

New research methods in identifying motivations for energy efficiency refurbishment of owner-occupied homes

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Abstract

Previous studies on home energy efficiency have traditionally focused on either the technical savings or on social aspects such as behavioural change. These studies have typically excluded the role of motivation, a key component in the implementation of energy efficiency refurbishment in owner-occupied housing. Previous research studies of motivation have typically incorporated Likert scales and questionnaire surveys, but this provides a somewhat superficial view of motivation and can result in disproportionate and inaccurate responses. A new research approach for investigating the motivation of home-owners for energy efficient refurbishment is presented. The approach incorporates in-depth interviews and a detailed physical survey of the properties to explore the underlying mechanisms for motivation for energy efficiency refurbishment, and to provide a means of comparison between cases. Through better integration of methods from the social science and surveying disciplines a more complete understanding of owner-occupier motivations for energy efficiency refurbishment and the underlying mechanisms affecting it can be realised.

Keywords: motivation, energy efficiency, refurbishment, interviews, surveys, housing, owner-occupier.

1 Introduction

The need to improve the energy performance of the existing housing stock has increasingly recognized in academic literature, reports and government policy [1, 2]. Since the introduction of insulation requirements in the Building Regulations in the 1970s to present day, performance has continued to improve. However, to



prevent irreversible damage to our climate and maintain comfort in our homes, further significant improvements are necessary in light of and climate change. It is understood that neither maintenance nor modest refurbishments will achieve necessary improvements [3]; without regulation, owner-occupied home energy improvements are left to the motivations of owner-occupiers.

The primary aim of this paper is to present a methodological procedure to investigate why owner-occupiers are motivated to undertake an energy efficiency refurbishment (EER) and how their EER motivation is affected by both their internal and external factors. To enable this, it is argued that a combination of social science methods and physical surveying methods is needed. Traditionally, these have been kept mutually separate in motivation studies. Although physical surveys have been previously used in studies of refurbishment and energy efficiency measure adoption, their use has typically focused on purely assessing property condition rather than providing greater contextual understanding. By drawing social science methods and surveying methods together it is suggested that findings can be more meaningful and provide deeper understanding.

2 Background

In the UK owner-occupied housing contributes to over two thirds of the existing housing stock, over half of which was built before 1945 [4, 5]. This dominant tenure has the greatest potential in terms of performance improvements and taking action [6] but, generally, people are yet to act [7]. For people to act, they must be motivated to do so.

The term ‘refurbishment’ has been used extensively without precise definition [8–10]. The NRC [4] defines it as works involving:

“multiple energy-efficiency measures—fabric, heating and renewable technologies—applied sequentially or as part of a whole house solution. Retrofit is the installation of a specific measure, such as fixing photovoltaic panels to a factory roof or fixing external solid-wall insulation to the front of a terraced house” (p. 8).

In this work, ‘refurbishment’ is defined as a substantial property renovation rather than minor maintenance and improvement works, to provide a performance not incorporated in the original design (adapted from [11]). Thus EER means a substantial property renovation, deliberately incorporating works to improve building energy efficiency performance. Like the NRC [4] definition above, this can be performed sequentially over time (i.e. piecemeal) or as a ‘whole house’ approach.

Motivation’, a concept which has been used in everyday language and academic literature, has numerous definitions [12]. An internal process, it is the precursor to action [12], energising and driving action [13]. For owner-occupiers to act, motivation is critical [14] and better understanding in relation to EER is vital.



3 Gaps in current research

There have been a variety of studies and reports investigating the extent to which the existing housing stock can be improved and how [15–17]. Model- and case-based research has proposed a range of feasible carbon emission reduction targets from less than 40% [17] to over 80% [16, 17]. Despite this uncertainty over achievable reduction levels, there is a consensus that the greatest reductions will only be met if all possible measures are installed [15–17]. Research has also highlighted the most cost and energy effective measures to install in housing [18]. Although necessary to assess and estimate the potential carbon and energy savings from the large, heterogeneous housing stock, models have numerous limitations as summarised in Table 1.

Table 1: Limitations of technical models for carbon and/or energy savings in the housing stock [19, 20].

SUMMARY OF MODEL LIMITATIONS
Lack of transparency (i.e. limited access to the raw input data) and therefore a lack of replicability.
Use of diverse sources of data for models, with varying degrees of representativeness and accuracy. This makes it difficult to identify the limitations of such models.
Assumptions and simple approximations where there were no or limited raw data, particularly with regards to social factors such as energy behaviour.
Likely omissions of various sectors of the domestic stock (e.g. building form, construction type, property age, household structure, tenure type, location, types of energy used).
Models are rarely combined with tested findings, i.e. tested findings against actual buildings.
Accuracy of predicting user behaviour and the interactions between user and technology.
Disaggregation of housing stock into categories.

With regard to the final point, low levels of disaggregation can produce only broad findings for relative differences between categories [19]. This is likely to make the exploration of achievable energy and carbon reductions across the housing stock difficult [19]. If a high level of disaggregation is used there is a risk that there will be limited amounts of supporting data for each category. Although high disaggregation will provide the opportunity to adjust numerous variables to enable a better fit with national statistics in the future, it can limit the predictive power of a model [19].

The literature recognises that actual savings and payback periods of improvements are not solely dependent on physical performance change but also on occupant behaviour [21], something which is difficult to reflect realistically in

models. Tools such as the Standard Assessment Procedure (SAP) use ‘standard occupancy’, enabling comparison across different house characteristics. However, when deciding whether to undertake EER and in what form (whole house vs. piecemeal—i.e. works are done all at once or sequentially), better understanding of the context and how homeowners use their home and energy is beneficial. Assumptions made about householder ‘behavioural factors’ with regard to energy consumption is seen as a primary weakness of models [19].

Where technical studies have typically excluded social aspects, social science has focused on them [2, 22]. Yet it is known that savings are greater when technical and behaviour changes are combined [23]. The danger is that if consideration is not given to behaviour, energy consumption can increase following refurbishment [22] as a result of the Khazzoom-Brookes postulate, (the ‘rebound effect’, based on ‘Jevons paradox’) [24]. This is used to explain why energy efficiency improvements do not deliver predicted energy savings—efficiency improvements makes comfort levels cheaper to attain and therefore energy consumption increases above predicted levels.

The rebound effect has been shown in the context of home improvements [22]. A potential result of EER is that owner-occupiers invest savings from efficiency improvements on improving their comfort levels by increasing internal temperatures [1]. Indeed, it has been found that more efficient UK homes have the propensity to consume more energy, but overall consume less energy due to efficiency savings [1]. Therefore, behavioural change needs to be addressed in parallel with physical interventions.

In energy saving and carbon reduction research, studies have typically concentrated on energy consumption behaviour [25, 26]. In housing and technology studies, this might extend to decision making in relation to purchasing decisions [14, 27], the meaning of ‘home’ [22] and pro-environmental behaviour [28, 29]. There has been, however, a gap in research regarding motivation to undertake home EER [2, 12]. Typically, the closest studies have come to this has been through case study research, outlining the measures installed but not the motivation for selection [16], and studies which incorporate an assessment of property condition [8, 10, 25]. From this disconnect it can be argued that social science studies and technical studies both exclude or limit consideration of how the physical environment (i.e. the property) might guide owner-occupier decisions to improve home performance; that is, how motivation to improve performance manifests.

Previously, physical surveys have only been incorporated into the methodology of a few studies. The purpose of physical surveys in these studies has been to better understand actual property condition [8, 30]; actual property condition in comparison with perceived condition [10]; for understanding of the ‘material culture’ and how it affects energy consumption [25]; or to ascertain whether a building is technically capable of being retrofitted [30]. In Munro and Leather [10] and Summerfield *et al.* [8] it is unclear as to whether these surveys were used for purposes other than assessing condition and general context, such as categorizing data to enable inter-category comparison.

In-depth interviews have also been used in previous studies investigating energy consumption [25], low carbon technology adoption [31] and energy efficiency home improvements [2] to enable cultural norms and factors such as values [25], better investigate contextual factors [2] and probe deeper than other methods permit [2], or investigate in greater depth answers given through methods such as questionnaires [26, 31].

Questionnaires are commonly used in home energy consumption [26], low carbon technology adoption [31] and environmental behavioural research (e.g. [28]). They rely on response accuracy [32] and, favouring closed-end questions [33], are unable to probe deeper with follow-up questions. In self-completion questionnaires, meanings cannot be clarified; completion of all questions and an answer quality cannot be ensured, particularly to open-ended questions; and it is difficult to cater for differing literacy levels. A closed question such as 'do you consider yourself motivated to improve home energy performance' could elicit a 'yes' or 'no' rather than investigating how and why such a response is given within the contextual constraints in which the respondent resides. Therefore the ability to investigate underlying mechanisms, or provide fuller contextual understanding through questionnaires is limited. In some studies [26], to investigate further the issues highlighted in questionnaires, in-depth interviews have been undertaken for a deeper investigation of the findings.

In psychology- [34] and environmental behavioural-based studies [28], motivation has traditionally been measured using scales. However, scales do not tend to provide "*a comprehensive review of motivation*" [35] (p. 69). They tend to simplify aspects and can result in disproportionate responses where respondents are uncertain or neutral regarding where they fit on the scale [35]. They rely on the accuracy of self-reported behaviour and therefore accuracy of respondent understanding about their reasons for behaving in certain ways; in psychology, this has been long understood not to be the case [32]. Scales cannot investigate underlying mechanisms. The internal factor motivation cannot be directly observed, although it may be indirectly observed where it leads to action. This questions whether scales are a sufficient measure of motivation, relying on self-report accuracy whilst excluding context, which is likely to shape motivation.

For example, where owner-occupiers report themselves to be highly motivated to undertake an EER but have yet to take action, this does not investigate why or how the individual is motivated, nor does it investigate how their context has affected their self-reported 'high motivation' – i.e. the underlying mechanisms are not explored. Further, scales, where not given full sufficient consideration at the design phase, can force respondents to select the 'neutral' middle option or, where an even number of response options, force the respondent to come down on one side or the other [36], irrespective of reality.

To better understand motivation in relation to owner-occupied home EER, there is a need to combine elements from social science methods and surveying methods. A more integrated mixed methods approach is required to provide depth and context-based understanding. This will be discussed next.

4 A framework for integrating social science with physical surveying

The new integrated mixed methods approach will facilitate better understanding of the context and the underlying mechanisms to determine why owner-occupier are motivated for EER, how these motivations are influenced by internal and external factors, and whether differences in motivations exist between those who have undertaken such works and those who have not. The method combines interviews, collection of participant characteristics, documentary evidence and a basic physical property survey. As motivation is affected by both internal and external factors [12], methods need to facilitate understanding and explore both aspects—the combination of methods enables this. Similar combinations have previously been used [25] but these have not explored motivations in any depth, often focusing on behavioural aspects.

4.1 Interviews

The purpose of the interview is to investigate why participants undertake EER, the underlying drivers for doing so, the internal and external factors affecting their decisions and the extent to which their values and beliefs influence their decisions. It is a technique considered to be able to get close the interviewees' meanings and interpretations of their social world [37], with the potential of discovering the perspective of the interviewee [38]. The use of in-depth, semi-structured interviews enables greater opportunity to elicit deep, rich data extending beyond the empirical (directly observable) and actual (what comes about independent from the researcher) domains of reality to the 'real domain' (the underlying mechanisms producing the phenomena), essential in relation to EER motivation.

With EER motivation, which is not directly observable unless action has been taken, it is vital to focus on the 'real domain'. Even after action has manifested, principal motives (e.g. savings, environment, social) are not directly evident, nor are the underlying mechanisms of motivation. In-depth interviews facilitate the exploration of these aspects, supported to varying degrees through physical surveys, collection of participant characteristics and documentary evidence.

The interview enables investigation into participant values and beliefs, the internal and external factors influencing their decisions in undertaking an EER or not. The use of in-depth, semi-structured interviews provides greater opportunity to probe for further information and clarify responses [39], thus providing the ability to enter into a dialogue with participants [38], eliciting responses which go some way to investigating whether, how and why participants are motivated to perform EER. It has flexibility to respond to the direction in which an interviewee takes the interview, to adjust questions to the interviewee's level of comprehension and articulacy [40] as well as adapting questions, where appropriate, to the type of property and energy efficiency works undertaken. However, it also retains a platform for comparison between interviews [40]. This is essential in the context of this study, as a range of participants from different

socio-demographic backgrounds will be incorporated in a range of different contexts—semi-structured interviewing will enable the tailoring of questions to the participant and their context, without losing the direction and platform for comparison.

Undertaking interviews in the participants' own home has the advantage of enabling a more complete understanding of the immediate context [38], enabling the interviewer to observe participants in their own environment. It also aims to reduce the interviewer's influence on interviewee responses [41] and temper the effects of 'power' on the dialogue [42]. It also provides the opportunity to undertake the physical survey.

4.2 Physical survey

The physical survey, as seen in previous studies [8, 10, 25, 30], can facilitate a comparison between interviewee perceptions and reality, although it has the potential to be of greater use.

The survey enables the categorization of properties and a comparison of motivations between categories. It should be used to provide greater understanding of the immediate context in which the interviewee lives, particularly as this will govern some of the decisions which have been made in relation to undertaking EER. The condition of the property, previous or existing, may have driven decisions to undertake works or not. Where other measures may have been better suited or acceptable alternatives to the actual works, a physical survey provides a foundation for the interviewer to probe deeper in the interview as a result of better understanding of the home context, providing the potential to explore the underlying mechanisms.

4.3 Participant characteristics

Basic information regarding occupant socio-demographics and other key information on environmental activities and participation in groups and networks will be captured as part of the study. Similarly to the physical survey, this provides a means of categorizing owner-occupiers for comparison.

The basic information on participant characteristics provides empirical data within which the real domain of reality can be further explored. For example, if the participant is a member of a local environmental group, what connection does this have to their motivations to improve home energy efficiency?

4.4 Documentary evidence

Where available, documentary evidence such as energy bills, Energy Performance Certificates, photographs, surveys, building specifications, construction drawings and guarantees will be used. These will complement the interviews and the physical surveys by corroborating information given or observed, or where building measures/elements are concealed (e.g. cavity wall insulation) or not accessible.

Documentary evidence will contribute to contextual understanding and enable the interviewer to probe deeper. It will also improve the accuracy of the physical survey and, therefore, the categorization of properties.

5 Discussion

Existing studies have utilised methods to provide a means by which to explore aspects of EER within the empirical and actual domains of reality. Although this is beneficial in outlining what can be achieved and how it might be achieved technically [15–17] and behaviourally [28, 29], it cannot provide sufficient depth in the study of owner-occupier motivation for EER. For this to be achieved, the underlying mechanisms must be explored.

Rather than focusing purely on social science aspects or technical aspects, a mixed methods approach incorporating surveying and social science is proposed as enabling a deeper understanding of the context in which the owner-occupier interacts. This facilitates an investigation into their EER motivation; that is, their motives and the priorities they assign to them.

Although there are limitations to self-completion questionnaires, including relying on respondent self-awareness and understanding, and accuracy [32], these are incorporated in this mixed methods approach to capture basic empirical information about the owner-occupier (e.g. socio-demographic information and participation in local groups and activities). This will enable data categorization for comparison, and also provide a basis from which the interviewer can explore further aspects within the interview. Therefore, although the information on participant characteristics will not go beyond the empirical and actual domains of reality, in combination with the physical survey, it lays the groundwork to do so.

Former studies have incorporated physical surveys of properties as a means of assessing their condition [8, 25, 30]. Rather than using this purely as a reference point against which to compare perceptions [10], a physical survey can be used to aid categorization, a better understanding the context (external factors), and deeper probing in the interview.

As the study's main method, the aim of the semi-structured interview is to investigate motivations as part of the real domain of reality, guided by a topic guide, basic occupant characteristics and physical survey. A semi-structured approach provides a degree of flexibility within which the interviewer can tailor the questions for the interviewee and the property where appropriate, but still retain a framework for comparison between interviewee responses [40].

6 Conclusion

Existing studies on energy efficiency and energy consumption have tended to focus on either technical or the social aspects. These have typically made use of technical models, interviews, physical surveys and questionnaires to varying extents.

Models and associated findings are not necessarily easily comparable due to a lack of transparency, the different assumptions used, the different information



sources used and the degree of disaggregation. Motivation studies have not been explored in EER, but have traditionally favoured the use of scales. However, these have been criticized as being open to inaccuracy, providing an incomplete view of motivation and not investigating underlying mechanisms. Like self-completion questionnaires, they can produce disproportionate responses without the ability to clarify or probe deeper. Alternative existing methods and combinations of methods have been limited to the empirical and actual domains of reality, neglecting motivation and the real domain of reality.

To explore motivation within the context of EER in owner-occupied housing, it is argued that a more integrated mixed methods approach is necessary. Such an approach should incorporate a physical property survey, providing deeper understanding of the context in which the participant functions to enable richer data to be generated through semi-structured interviews. The use of documentary evidence is suggested as a means to corroborate data collected during the survey and interview.

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