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A Practitioner Study into the Variability of UK Domestic Energy Assessments

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Abstract

Purpose

This paper focuses on the assessment of a domestic property's energy performance status by a Domestic Energy Assessor (DEA), to ascertain the possible underlying reasons for variability in the results of Energy Performance Certificates (EPCs). By variability we mean discrepancies in assessment between different DEAs on similar properties. This is important because the uses for the EPC have been extended beyond their original function as an asset rating system, to include a wider range of themes encompassing issues such as building policy decisions, building performance, and the distribution of incentives and grants. As a consequence, inaccuracies in EPC reporting will have a greater impact than may have been the case at their outset.

Methodology

A case study approach involving the conducting of semi-structured interviews with twenty practicing DEAs was carried out, with transcribed recordings of the interview material subjected to thematic analysis. This formed part of a wider mixed methods study.

Findings

The results identify a wide range of underlying reasons for variability driven by issues in both practice and process, including conflicts of interests, the EPC auditing process, the default inputting of missing data by RdSAP where information may not be available/discoverable by the DEA, the quality and perception of EPCs, and DEA training and experience.

Practical implications

The research identifies risks to the accuracy of EPCs. To this end, and with the specific research findings in mind, this research may be of interest to construction professionals in respect to EPC practice and procurement, to the Accrediting Bodies who audit EPCs, to the creators of RdSAP with respect to automated EPC inputs, to academics either at face value or for use in further research, and to policy makers who may wish to consider RdSAP data in future with qualifiers or margins of error, or may even look to review the EPC as the instrument of choice for some applications.

Research limitations

The sample size of twenty is by definition limiting, and it is possible that different results would have been obtained from a different sample. Although thematic saturation from the analysis of the responses on the key question of whether EPCs are considered variable, does mitigate this. The respondents were all in possession of five

years or more experience, and of carrying out EPCs for different purposes. Less experienced DEAs may inevitably have responded to questions differently. Thematic analysis gives the researcher control over presentation of the results, and it is noted that this creates potential for bias. The researcher is immersed in the world of construction and property, with regular contact with DEAs and EPCs, which may influence the perspective of the results.

Originality

There is much literature analysing the shortcomings and nuances of RdSAP results, the software model that generates the EPC, but only very limited literature extending the discussion about RdSAP to its operator: the DEA. At the time of writing, there is no literature focusing directly on the DEA and their role within the EPC production process. Their role is more important now, given the expanding use of EPCs, and increased reliance on EPC data.

Keywords: Buildings, Residential, DEA, EPC, Energy Efficiency, Assessment, SAP, RdSAP

1.0 Introduction

The process for assessing the energy performance of a residential property, the Energy Performance Certificate, is now used to underpin a wide range of activities, from analysis of data en-masse to draw conclusions for academics and policy makers (Hardy & Glew, 2019), the management of social housing energy efficiency (Longhurst & Hargreaves, 2019), to the underpinning assessment tool for the likes of the MEES (Minimum Energy Efficiency Standards) legislation (BEIS, 2017). It does so against a focus on improving energy efficiency to help reduce the estimated 23% of total Greenhouse Gas (GHG) emissions in the UK for which buildings are responsible (Committee on Climate Change, 2019), as well as policy goals addressing fuel poverty (Committee on Fuel Poverty, 2018). With such a significant proportion of carbon emitted by buildings, it is clear to see why there is considerable focus on reducing building-related carbon emissions to achieve the targets set out in the 2008 Climate Change Act (UK Government 2008).

In order to monitor progress against energy performance and emissions targets, building carbon output and savings must be measured or modelled, and it is the assessment process, which identifies the modelled performance of a building, which forms the focus of this paper. Fylan (Fylan et al., 2016). notes that up to 75% of existing UK housing stock will still be standing in 2050. The UK's residential building stock is also much older than that of most other developed countries in the world, with 40 per cent of UK buildings constructed prior to 1944 (Dixon, Gupta, 2008). This presents additional challenges for the UK over its European counterparts. It is the assessment of the energy efficient status of the dwelling and the scrutiny of high-level data by academics and policy makers, as well as the benefits that may be attributed to retrofitted energy efficient installations by individual householders and installers that underpin the focus of this paper. Before building up the more specific context and presenting the results, we consider the important components of this

study; the energy performance certificate, its policy context, and the role of domestic energy assessor, are first briefly explained.

2.0 Energy Performance Certificates

The energy performance certificate (EPC) for existing dwellings is a short report, created by a qualified domestic energy assessor (DEA) using the 'reduced data standard assessment procedure', or RdSAP. RdSAP works by assessing how much energy a dwelling will consume, by using a high-level, static building physics model, when delivering a defined level of comfort and energy service delivery for primarily, provision of heating and hot water (DECC, 2014). The EPC presents the householder with an overview of dwelling energy efficiency, including dwelling fabric and anticipated energy use, generating a 'SAP rating'. This SAP rating is presented as a number on a scale from 1-100 (1 being very poor; 100 being very efficient). These numbers fall within a banding of A (most efficient) to G (least efficient). The assessment is based on standardised assumptions for occupancy and behaviour (DECC, 2014). This can lead to a misconception that the EPC should present a high level of accuracy in respect of the functioning building *in use by its occupants*. However varying levels of actual dwelling occupation, coupled with personalised levels of energy use will naturally contribute to a deviation in actual, versus predicted EPC energy use (Summerfield et. al., 2010). This behavioural in-use variability is not the focus of the variability referred to here. We are specifically concerned with the variability of differences in input into the RdSAP model by assessors, which lead to differences of EPC outcomes for properties with the same, or similar attributes. It is the accuracy of this like for like building comparison, and the perceived benefit of heating and insulation measures that is at risk if assessors are producing EPCs that vary with one another.

2.1 The EPC and UK energy policy

The EPC was introduced in various stages throughout the UK from 2007 to 2009, to fulfil the requirements of the EU Directive 2002/91/EC on the Energy Performance of Buildings Directive (Brussels: European Parliament and Council, 2003). The EPC reports were initially designed to 'enhance the role of building energy efficiency for all buildings sold and let; using the SAP rating as a trigger for improving the energy efficiency of buildings; and introducing minimum SAP ratings into the building regulations for the construction of new buildings' (Kelly, Crawford-Brown et al., 2012). The EPC report must be made available to prospective buyers or tenants prior to entering into a contract and is valid for up to 10 years (EU Commission, 2002).

While the originally intended use of the EPC, as required by the EU Commission, is ongoing, they now have added relevance within the broader context of carbon and energy savings within buildings. For example, EPC data from the government's EPC Register, the English Housing Survey (EHS), and the National Energy Efficiency Data-Framework (NEED) is used for en-masse analysis (MHCLG, 2019, BEIS, 2019) by government departments, professionals, and academics. This feeds into national projections for energy efficiency savings, decisions around the future of grant funded

energy retrofit programmes, the government's 'fuel poverty' statistics, and other energy-related matters (BEIS, 2019; MHCLG, 2019, DECC, 2015).

This broadening use of the EPC is central to the focus of this paper, because the need for accuracy is of greater importance than ever, when significant policy decisions are being made on the strength of the data. The quality of EPC data - and consequently the EPC itself as an appropriate tool for these broadening uses - is being called into question (Organ, 2021). This underpins the interview questionnaire put to qualified Domestic Energy Assessors in Section 4.

2.2 The Domestic Energy Assessor (DEA)

The Domestic Energy Assessor is the competent individual responsible for the reporting of EPCs. The assessor must undertake training, pass a qualification, and become a member of an accrediting body (MHCLG, 2021). At its quickest, the qualification can be completed by a person with no related experience in five days at a cost of around £1,500 (Elmhurst Energy, 2021).

'Accrediting bodies' are the groups to which DEAs must belong if they are to produce EPCs. They provide the software platform and have a requirement to audit the DEA's work. Depending on the number of EPCs produced by a DEA, audits are carried out by the periodic, random selection of a DEA's EPC submissions (BRE, 2017). Recent updates to the auditing procedure have seen the introduction of 'targeted audits', where atypical or unexpected EPC data is flagged up for audit scrutiny. However, all checks are based on a desktop review of photographs and site notes, rather than a physical site visit.

3.0 Current EPC Research

There is a growing body of literature whose focus is upon EPC variation, and this marks the backdrop for this research. The research points to the existence of variability but the studies are less clear on the underlying reasons. It should be noted that variability is not limited to the energy modelling field within surveying practice. Kempton (Kempton et al., 2000) noted that variability among surveyors is not necessarily to be construed as error, but as difference of professional opinion between individuals (Kempton et al. 2000). Kempton notes that 'any variation in surveyor performance can significantly impact on the accuracy and, therefore, the effectiveness of data' (Kempton et al., 2001). A degree of variability in EPC outcomes en-masse may be expected to 'come out in the wash', but without knowledge of how variability occurs, we cannot be assured of this. What is arguably of greater concern is the concept of 'surveyor drift' (Kempton, Nicol et al. 2000), where interpretation of survey information is increasingly more, or less strongly recorded as a group. Overall, it may be reasonable to suggest that production of an EPC from RdSAP is not as complex or as subjective as the building surveying activities that Kempton was referring to, and it should follow that variability would not be so pronounced for the DEA. However, for every missing piece of information, assumptions are made by the RdSAP model which in turn could lead to a form of 'automated drift', as the software model assumes a worst-case scenario in many instances (BRE, 2017). The theme of

RdSAP 'rounding down' in more instances than not was identified by the DEAs interviewed here and is discussed in sections 4 and 5. Ahern (Ahern and Norton, 2019) carried out a study of EPC data that points to evidence supporting this phenomenon, but until now there is no literature marking the opinion of DEAs on the matter.

3.1 EPC Variability

Jenkins et al, (2017) undertook a study whose scope encompassed four energy assessments on each of 29 different properties under the guise of a 'mystery shopper' exercise, as part of the now defunct Green Deal (Mallaburn & Eyre, 2014). The results were benchmarked against a 'control' by a commissioned firm of DEAs, and show (at times, quite significant) variations in outcomes from one assessor to another, although the reasons for variability are not the focus of Jenkins' paper, rather the extent of variability and the implications for this.

A unique case which may be seen as fulfilling the element of scale that Jenkins notes as a limitation in his own work, is that undertaken by Hardy (Hardy & Glew, 2019), who use EPC data compiled by DLUHC into quarterly statistics (MHCLG, 2019) to compare historic and current EPCs held under the same address. All EPCs lodged in England and Wales were scrutinised for this purpose. Their research points to erroneous data in at least 27% of all EPCs where more than one EPC has been produced at the same property for any reason (up to 2016 when the study began).

Ahern (Ahern & Norton, 2020) investigated the effect of RdSAP default data on dwellings in Ireland where energy efficient improvements were recommended. They assert that the EPC overstates the benefits attributable to the improvements and describe this as a 'prebound effect'. They investigate the default assumptions made by RdSAP and assert that they are unrealistic, primarily because most dwellings - especially older dwellings - have been improved since construction and RdSAP does not account for this. This is primarily an issue connected with the 'performance gap' – the variation between measured and modelled savings, but it marks a theme within RdSAP that the interviewed DEAs were keen to discuss during this study, and which has implications for RdSAP's relationship with its user.

In a further study, Tronchin (Tronchin & Fabbri, 2012) studies the results of 162 EPCs, all performed at the same detached single storey dwelling in an Italian town. Notwithstanding the software itself, which was not RdSAP and by the author's own admission was new to all participants and may have had shortcomings of its own, the participants themselves were described by Tronchin as experienced experts from surveying, architectural, engineering or specific energy related backgrounds. He found over 70% of his 162 participants 'correctly' scored the property with an energy rating of Band D but of the remainder, 14.2% allocated the property a Band C, 9.26% allocated the property a Band E, 3.7% a Band B, and 0.62% gave the dwelling a Band A. Tronchin's research looks at variability itself and does not address the reasons for it, but attributes the erroneous data (Bands A, B, C and E) to 'incorrect computer and software use, where input data was not properly understood'. Interviewing the assessors following this exercise may have yielded interesting results. In particular, themes such as a lack of understanding of the assessment conventions, the building

itself, or the software/technology may have been an issue here, but this is speculation as the paper discusses only the extent of variability, and not the reasons for it.

Consistent with the findings of Tronchin, Hardy, Ahern and Jenkins, an enquiry into energy performance certificates, (Gledhill et al., 2016) explored variability by modelling errors that may, hypothetically, be made at the surveying/inputting stage, and analysing the outcomes that were found in the finalised energy performance certificates. Here, a wide range of outcomes could be modelled based on relatively small changes in inputs, making clear the need for careful attention to detail and precise measurement in order to produce consistent, accurate EPCs.

3.2 Variability, EPCs and the DEA

EPC variability is established to varying extents in the studies discussed above. In summary and of relevance to this research, Hardy & Glew note the existence of erroneous data following a large-scale review of all duplicated EPCs from the EPC database, although the paper's focus (intentionally) does not extend to how the DEA may have contributed to this; Ahern & Norton note the inaccuracies of RdSAP when recording energy efficient improvements, and the 'rounding down' effect of RdSAP. This by definition focuses primarily on the RdSAP model and not its user; Tronchin & Fabbri recorded a wide range of results following the appraisal of a single, relatively simple bungalow which may have yielded further material if those producing the reports were interviewed for their thoughts afterwards, and Gledhill recorded hypothetical EPC outcomes by making adjustments to EPC inputs, which show the vulnerabilities of RdSAP should it be mistakenly used, or misused.

Most closely linked with this research, Jenkins' mystery shopper study records a range of EPC outcomes with use of a benchmark, at 29 different properties, but while the results are recorded and the potential causes for variation discussed, those who carried out the EPCs were not contacted for their views on the research, or to contribute to it. At the time of writing, there is no literature exploring the views of the energy assessors who produce these reports; in particular whether they perceive a level of variability in their own, or in their peer's work and critically, if so, what may be the underlying reasons for these differences, and what may be done to improve the accuracy of EPCs. This may be regarded as a gap in the research of an area that has important ramifications. This research looks to build upon the existing literature identifying EPC variation by gauging the views of the practitioners who produce EPCs; more specifically whether they have views about if/how the DEA may be contributing to variation. The research addresses this by carrying out a case study involving the interviewing of DEAs about their work, and in the next section, the research method is discussed.

4.0 Case study method, sample and analysis

The case study focused on the experiences of practising DEAs in the field and was carried out between January 2016 and March 2017. A number of different methods for carrying out this research were considered, including focus groups, postal surveys, and online surveys, but one-to-one interviews were settled upon as the preferred method following reflection upon the ability of individual DEAs to give their own,

uninterrupted and unbiased views, without the potential for a period of reflection or first hearing the opinions of others. The objectives were to (i) explore their experiences during the assessment process that leads to the production of an EPC, and (ii) seek reflections on their roles, the existence of variability within EPCs, and (iii) understand how the surveying process might be improved to minimise the various causes of variability. In exploring the views of DEAs and seeking their reflections, a qualitative, rather than the more formulaic approach of a quantitative route was taken.

4.1 Sample frame

The sample frame used to identify the DEAs was that of a catalogue of consultant DEAs previously used by insulation installers to produce EPCs as part of their compliance process, under the government's Energy Company Obligation (ECO) scheme. A DEA's contact details are published on each completed EPC, and DEAs were contacted using these. A total of 46 DEAs were contacted randomly from a catalogue of over 100, and the study aim and purpose was discussed. Of the 46 individuals who were contacted, 20 agreed to take part. At the time the study took place, each of the DEAs were producing EPCs on a full-time basis for both sale/rental, and grant funded or subsidised schemes, such as the ECO.

4.2 Survey question set

The questions posed were designed to ensure DEAs were not lead down the path of any particular response. A qualitative, semi-structured interview method was adopted, following consideration of the alternatives where open ended questions could present the researcher with an unnecessarily large amount of (potentially abortive) data to transcribe and code, and structured, quantitatively coded interviews may be too short and leave out the potential for useful insights to be collected for an exploratory study such as this. Morgan (1998), noted that the semi-structured interview gave the opportunity not just to relay what is undertaken (during the process of gathering the EPC data in this case), but also to look at the contradictions and complexities of how things work in practice. This suits the research well. The interview question set was as follows:

1. What is your professional background?

2. How long have you held your DEA qualification for, and how many EPCs would you estimate you have produced in total?

3. What are your thoughts about the EPC *process*?

4. What do you find are biggest issues in getting a full appraisal of the property, when carrying out an EPC?

5. Do you think EPCs are variable between Assessors?

    a. (If yes) What do you feel the main causes of the variations are?
    b. (If no) What are the main reasons for the consistency?

6. What do you think are the key variables that would have an influence on the results of an EPC?

7. Do you think that the outcome of an EPC produced for sale or rental would be the same as that produced for a different purpose, for example under the government's Energy Company Obligation (ECO), or the Feed in Tariff (FIT)?

8. What improvements would ***you*** make to the EPC process?

9. Finally, is there anything you'd like to add?

Each semi-structured interview was undertaken either face-to-face, or over the phone. Each was recorded, and subsequently transcribed. All respondents, and the organisations to whom they were affiliated, were assured of their anonymity. The table below outlines the respondent's work and academic backgrounds.

Respondent	Background	Academic qualifications	Professional qualifications	Years' experience
1	Building/Construction	Relevant Degree	Qualified DEA	> 15 years related
2	Insulation/Energy Surveying	Relevant HNC level	Qualified DEA	> 10 years related
3	Professional not-related	No relevant FE/HE	Qualified DEA/MNAEA	> 10 years related
4	Building/Construction	Relevant HND level	Qualified DEA	> 10 years related
5	Insulation/Energy Surveying	No relevant FE/HE	Qualified DEA/OCDEA	> 15 years related
6	Insulation/Energy Surveying	No relevant FE/HE	Qualified DEA	> 15 years related
7	Property Letting/Management	Relevant Degree	Qualified DEA	> 10 years related
8	Professional not-related	No relevant FE/HE	Qualified DEA	> 10 years related
9	Building Surveying	Relevant Masters	Qualified DEA	> 20 years related
10	Insulation/Construction	No relevant FE/HE	Qualified DEA	> 20 years related
11	Architectural technician	Relevant HND level	Qualified DEA	> 20 years related
12	Architectural technician	Relevant HND level	Qualified DEA	> 10 years related
13	Housing Management	No relevant FE/HE	Qualified DEA	> 5 years related
14	Housing Management	Relevant Masters	Qualified DEA	> 5 years related
15	Building Surveying	Relevant Degree	Qualified DEA/MRICS	> 15 years related
16	Professional not-related	No relevant FE/HE	Qualified DEA	> 5 years related

17	Conveyancing/Energy surveying	No relevant FE/HE	Qualified DEA/OCDEA	> 15 years related
18	Housing Management	No relevant FE/HE	Qualified DEA	> 10 years related
19	Housing Management	No relevant FE/HE	Qualified DEA	>10 years related
20	Housing Management	Currently in related FE	Qualified DEA	> 5 years related

Table 1: description of the sample of interviewees

4.3 Analysis

The main questions invited some open-ended responses, which were subject to a thematic analysis process based on the approaches laid out in Braun and Clarke, (2006), involving systematically working through transcripts and identifying content which could be divided into themes. The transcription process itself allowed the researcher to familiarise himself with the data; Bird (2005) noted the transcription process was 'a key phase of data analysis within interpretative qualitative methodology'. Following transcription, themes were comparatively straightforward, and use of coding software was not considered necessary. More sophisticated alternatives to thematic analysis were considered but were deemed unnecessary given the material here is not overly complex, nor is there significant depth or nuance to analyse.

4.4 Limitations

The sample size of 20 is limited, and when drawing conclusions from a small sample it must be acknowledged that the opinions expressed are not necessarily representative of the wider profession. Whilst acknowledging the restrictions of time and resource that may be anticipated for a single lead researcher, sample size limitation was mitigated against by carrying out interviews over two phases of ten, in order that material could be transcribed and results digested. While key themes emerged prominently over the course of the first ten interviews, in an effort to reach some 'saturation' of results, a further ten interviews were carried out, just under a year later, to build robustness into the results. Key themes again emerged strongly.

Reaching saturation has become a critical component of qualitative research that helps aid data robustness and validity (O'Reilly & Parker, 2013). The concept of saturation is used in wide ranging approaches to qualitative research, where it may be referred to as 'data saturation' or 'thematic saturation' (Hennink et al., 2017). Further, saturation is 'the most frequently identified guarantee of qualitative rigor offered by authors to reviewers and readers' (Morse, 2015). Hennink & Kaiser (2017) carried out a review of qualitative research papers stored in databases with a focus upon a variety of topics, in order to assess sample sizes, strategies, and draw inferences for saturation in research studies. Many of these studies were grounded in a medical context, although the research was not bound by any particular subject material. There is discussion in this paper about the balance between sample size and breadth/extent and specific content of interview material, which can make establishing saturation - and the numbers involved in achieving it - a challenging concept. Most of the data they reviewed was obtained following interviews (10 from 17), although other qualitative

methods were used, and in some cases, more than one qualitative method was used. While there were nuances in the way saturation is defined from one author to the next, and variations in the strategies used to establish saturation, the researchers standardised this by recording saturation as being at/closest to 90% of consistency across results. In doing so, most of the datasets reached saturation at between 9 and 17 interviews, with a mean of 12–13 interviews, with a small number of 'outliers' requiring more than this due to the complexity of heterogeneity of the research material.

Hennink's results are similar to a separate study by Guest et. al., (2006), which also sought to establish saturation among a range of qualitative data and reported saturation at 12 interviews. While not empirical, the research material of this study may not be regarded as unusually heterogenous, maybe primarily because it focuses on one profession, bounded by one central theme, located in one country. Further, saturation of 100% was achieved when asking the key question (question 5 – see Section 4.2 above) 'do you think EPCs are variable between assessors?' Finally, the study sought to discredit the notion that saturation, hence the number of interviews needed can be predicted by a statistical model, *a priori*, due to the complexities and nuances associated with the data and the data collection process of any given exercise. In this research, the first ten interviews were carried out independently of the second tranche of ten, in order to gauge the consistency and type of themes emerging, and estimate the likely number of additional interviews required before they may be considered fit for the purpose of drawing inferences. The research outlined here was also considered when identifying how many interviews might best suit this study.

Another limitation is identified in the experience of the DEAs interviewed. It was thought likely that contacting consultant DEAs would yield individuals with some more experience of producing EPCs than the wider profession. Table 1 shows that none of the DEAs interviewed have less than five years' experience. DEAs who have only recently qualified, or those with no previous construction and property experience may have given a different perspective.

It should be noted that the issue of variability of EPCs is central to the focus of this paper. The issues picked up from interviewees and reported here are those considered most pertinent by the author, who had a pre-formed hypothesis about EPC outcomes (though not the EPC *process*) prior to embarking upon this study.

5.0 Findings

This section presents extracts from the themes that emerged during interviews with the respondents. It is important to note that while questions were put to DEAs in such a way as to glean feedback on their own views and processes, many DEAs broadened their response to encompass the wider profession. For point of note, following transcription, themes were comparatively straightforward, and use of coding software was not considered necessary. The emerging themes may be placed into six broad categories: 1) the EPC process, 2) challenges facing DEAs on site, 3) EPC variability, 4) RdSAP assumptions or defaults, 5) the perceived and monetary value of EPCs, and 6) misrepresented, or wilfully manipulated EPC data. Extracts and discussion begin with the EPC process.

5.1 The EPC process

Seventeen of the respondents described the EPC process using words including 'simple', 'straightforward', 'clear', 'unambiguous' and 'realistic'. The consensus among all respondents was that the EPC process was transparent.

However, an early theme emerged regarding the amount of control DEAs had over EPC outcomes, with concerns that the assumptions being made on their behalf by the RdSAP model were not always accurate, and that this could lead to a misleading EPC. In supporting this point, the non-intrusive nature of the EPC process was brought as a shortcoming of the process which led to the need for RdSAP assumptions.

> *'A lot of the EPC is assumed, because it's not an intrusive survey, and I think that could lead to a lot of different outcomes'*. DEA 4

Two DEAs go on to explain in more detail what concerns them about the nature of assumptions, relative to access and the non-intrusive nature of the EPC process:

> *'For example, I was in a property last week and the property owner had put under-floor insulation in the property and asked if I could include it, but I said no you can't because I can't see it and there's no paperwork for it. I have to put unknown, and once I'd done this ..... the EPC was three points lower than it would have been'*. DEA 9

In respect of obtaining a full appraisal of the property in order to collect all the data required to produce an EPC, nearly all DEAs mentioned the practicalities of obtaining access to various parts of a property as an issue that may not always be appreciated in theory. In addition to this, householders themselves were criticised in some cases, as being a barrier to the careful and methodical collection of data.

5.2 Existence of EPC variability

The initial question was 'Do you think that EPCs are variable between Assessors?'. All twenty respondents answered to the affirmative, some emphatically so:

> *'Hugely.'* DEA 3, *'Yes, definitely.'* DEA 2, and *'Absolutely.'* DEA 12.

The follow-up question to this provoked the need for some elaboration, and nineteen of the twenty respondents expanded their answers. Some highlighted issues that may be categorised as 'human error'. This might be consistent with variability theory put forward by Kempton et al. discussed in Section 2.3. Respondents pointed to a range of issues that would lead to variability, including heating and insulation provision within a property, but measurement was noted as being a primary source of variation by most DEAs. This presents an issue because – as noted Section 2.2 – measurement is arguably the most challenging aspect to verify using the current auditing procedure for EPCs, which is carried out from behind a desk and does not extend to a site-based validation of the DEA's work.

> *'Yes, if I went to do an EPC and another surveyor did, I'll bet that the two results will be different. Things like dimensions and how you split up the property, doing heat loss perimeters and things like that'.* DEA 7

A point made regarding the effect of secondary heating systems on the overall EPC score is also noted by Gledhill et al (Gledhill et al., 2016).

> *'…focal point fires, those tend to drop it by as much as five points, and if people miss them. For me it's a big variable. You have to reflect, and make sure it's correct'.* DEA 9

Gledhill also makes a point about interpretation of the conventions and experience, and the same assertion is made by a number of DEAs, including DEA 6:

> *'It's interpretation of what you're looking at, one individual may look at two drill holes in a wall and say it has cavity wall insulation, the other might say well hang on, there should be over one hundred drill holes to denote cavity insulation. That's something else like wall ties. It's down to the experience of the individual'.* DEA 6

The respondent's comments may be taken as a criticism of the level of experience of some DEAs, and this may link back to the way DEAs are trained, following a course that can take as little as five working days, with no previous experience needed for eligibility onto training.

5.3 Misrepresentation of EPC data

Human error of this nature might be broadly anticipated, although there may be ways of minimising this and/or mitigating against it which are discussed later. However, all respondents made comments relating to the subconscious, or worse still the wilful manipulation of data that could be considered cause for concern and could potentially be described as 'deliberately misrepresented EPC data'.

DEA 2 asserts that the assessment process varies dependent upon the purpose for which the EPC is commissioned:

> *'I think these are being done with different objectives. For sale or marketing of a property…the benefit is for it to be a higher score and make it look a more economical place to live, whereas those for the carbon scoring for energy efficiency measures it's the opposite and you want to show there is an improvement to be made so the lower the score the bigger the improvement of the energy efficiency measure…. And yes I think that has a massive effect on the overall methodology people are using and the score that results'.* DEA 2

Twelve of the twenty respondents made outright claims regarding the deliberate misrepresentation of data.

> *'EPCs for sale and rental market are quite straightforward but those are manipulated sometimes to make a property more attractive by the estate agent and the EPC isn't as accurate as it should be'.* DEA 3

This is consistent with the literature presented earlier in this paper. DEA 2 also notes that:

> *'The dimensions which is something that is very difficult to challenge (during an audit by the Accrediting Body) because when it's looked at and audited and checked it's done from photographs. So, looking at it you can't necessarily say if its shorter or longer than its being presented, and you can't really check against that or prove against that without going on site and doing that'.* DEA 2

Site based audits of EPCs by Accrediting Bodies do not take place (BRE, 2017).

Three DEAs pointed to personal experience of pressure from employers to manipulate EPC data. DEA 4 made an assertion from his own experience.

> *'...as far as I know a lot of people are basically lying about meterage and stuff like that ... you can engineer the EPC to say what you want it to say. If you need a high carbon content out of the property then you can manipulate the EPC. I actually stopped doing EPCs for a solar panel company because they wanted me to manipulate EPCs, and I wouldn't do it.'.* DEA 4

DEA 4 also asserted that audits by Accrediting Bodies are not robust in his opinion:

> *'They (DEAs) make the audit fit what they've lodged rather than it being a true and accurate assessment of the property. I know people who keep a photograph (of various building elements) and they submit them as their evidence (for audit) as and when required'.* DEA 4

These anecdotes point to a potential issue of manipulation of EPC data, but this should be tempered with the fact that this is a matter of perception rather than fact based on robust data. No direct proof of this is given to support this view.

5.4 RdSAP assumptions

When certain information is omitted, the RdSAP model defaults to an assumption, which in many cases may lower the SAP score, because RdSAP places a worse-case scenario default where information intended to be collected by the DEA is missing (BRE, 2017). DEA 1 is concerned that DEAs have realised this, and are using the defaults to manipulate an outcome that better suits their requirements:

> *'...it can allow for shortcuts to be taken so where possibly more information could have been available it may be in the DEA's interest to not research all of that and take the extra step, to take the path of least resistance and to take a way that isn't cheating and is within the rules but isn't quite as accurate as it could be. How DEAs approach this is quite variable, you don't want that when you're doing this really'.* DEA 1

This default position of rounding down where no, or limited information is available is discussed in the hypothetical exercise undertaken by Gledhill (Gledhill et al., 2016). This supports the interview findings here.

Four DEAs remarked in similar ways that an invasive inspection might be more appropriate, given the uses to which the EPC is now put. DEA 6 suggested that only a more intrusive inspection would yield the level of robustness that should be expected of the EPC.

> *'The downside of (RdSAP) EPCs is that it's assuming too much. The on-construction EPCs (FSAP) don't assume anything, do they, but with RdSAP it's assuming too much. I think we should investigate things more.'* DEA 6

This acknowledgement by the respondent of RdSAP automating missing or unavailable data is a theme that links with the misrepresentation of EPC data, discussed in Section 5.2 above and studied by Ahern et al. (2020) three years after these interviews were carried out (see Section 3.1 above). This is consistent with the findings here, and triangulation with the literature of this nature may be seen to support the research.

5.5 EPC Auditing

The remarks made by respondents in the latter sections of the interview revolved predominantly around two key areas: the first, mentioned by eight DEAs during their interview was the need for a more robust auditing procedure from Accrediting Bodies. DEA 1 makes assertions both about the knowledge and understanding of the auditors themselves, and about the need, in his opinion, for on-site auditing:

> *'I think the auditing process needs improving. A lot of it is done by people who haven't actually done EPCs. I think they should actually visit site rather than review photos (from behind a desk). It's very easy to submit evidence to pass your audit'.* DEA 1

This was a theme touched upon by many of the interviewed DEAs, and which runs through the sections of this paper. Concern was expressed by five DEAs that only on-site auditing would be wholly effective. Along the same theme, some DEAs expressed concern that even after being caught manipulating EPC data, auditing bodies did little to reprimand offending DEAs.

> *'I think the audits should be more strict. So that some people who manipulate the EPCs for their own financial gain, even when they've been caught out by the accrediting bodies they get a slap on the wrist and don't do it again, and another chance… well I think there shouldn't be another chance and if you get caught out blatantly producing incorrect EPCs then you should be struck off and not allowed to produce them'.* DEA 4

The issues with the audit process and how it may be developed does mean there is value in understanding the process as practised in more detail.

5.6 DEA training

A common theme which runs throughout the interviews, mentioned by nine DEAs was the need for more rigorous, or improved training. DEA 11 expresses concern

about the speed with which DEAs can obtain their qualification. The comments here include a point brought up by many of the more experienced DEAs, that a relevant professional qualification prior to being accepted for training as a DEA may be prudent.

> *'I think there needs to be a prerequisite to becoming a DEA, or at least improve the training, the course itself. Training in five days to become a DEA with no background at all and be out there doing the same job as myself who's been doing it for years, well it's a little bit wrong, and they'll be getting them wrong'.* DEA 11

While the point made here could be seen as self-protection, this may be a worthy consideration to revert back to if further investigations establish that variation between assessors exists. DEA 4 offers a similar view, pointing to inadequate training and a lack of previous experience as likely contributors to any variation.

> *...'there are too many DEAs out there that have been trained too quickly from a non-building background so they don't understand the data they're collecting and they don't understand why they're producing the EPC, they're just putting in the data and letting it spit out the other end. I think it should be clamped down and a lot of re-training going on'.* DEA 4

This may suggest that, in the view of the respondents, recruiting DEAs from construction or construction related professions is important.

5.7 The cost and value of EPCs

A final theme that emerged from many DEAs during interviews was that of the cost and value of EPCs. While cost and value may be considered two distinct issues, they are intrinsically linked. Nearly all DEAs asserted that remuneration for EPCs was so low that completing them to a high standard was challenging.

> *'I would make it more professional. I think they could have more worth and that the prices charged for EPCs should be higher'.* DEA 5

Many of the interviewed DEAs had a low opinion of the EPC's perceived value to the public. DEA 12's comments may be considered typical of the point many were making:

> *'I think people just see it as a piece of paper, for paper's sake you know what I mean, nobody really wants to have one done because they don't understand them or don't know how to use them'.* DEA 12

While the interview material above does not provide conclusive evidence of failings in the EPC process, themes emerge from this material that may warrant further investigation. These themes are analysed in Section 6 below.

6.0 Discussion

All the DEAs interviewed stated there was variability of EPCs driven by DEAs. In addition to this, there was some consistency in their explanations as to why this

variability comes about. Errors relating to simple tasks, such as measurement of dimensions and insulation depths were pointed to, with the subject of poor remuneration arising regularly, such that EPCs may be rushed, leading to simple errors, although this latter point may be a question of inaccuracy rather than variability, driven by a perceived lack of resource within the system. More complex errors relating to a potential lack of DEA understanding of the complex 'conventions' (the rules relating to data collection and input) were also relayed.

The interviewees touched upon the differing purposes for which the EPC is now used, and suggested this might lead to DEA-manipulated outcomes. This might be done to enhance a dwelling's energy efficient 'score' to give the appearance of a property that is cheaper to heat and light in the case of sale and rental properties, or the DEA could input less data and rely on the model's assumptions, in cognisance of the RdSAP defaults tending to revert to a worse-case scenario, whereby the benefit of insulation measures - once recorded on the EPC - can be maximised. However, there is no clear direct evidence of wilful manipulation of EPC data from this study in the way it is asserted by some DEAs. In addressing potential solutions for the asserted wilful manipulation of EPC data, interviewees pointed to the role of Accrediting Bodies, recommending they take a firm lead in auditing EPCs, and in reprimanding DEAs who do not meet the required standards. On-site audits were considered by many to be an appropriate way of addressing shortcomings.

The way in which EPCs are commissioned was thought in some instances to bring pressure to bear on DEAs to achieve a particular outcome. The study by Jenkins et al (2017) where all the DEAs involved were commissioned to produce Green Deal Advice Reports could potentially have been influenced by this, if merit is to be attributed to the material volunteered by DEAs in this research. More generally, this is pertinent in the context of the minimum 'E' Rating for residential let property (BEIS, 2017), which is soon to be revised upwards, and following the minimum 'D' Rating required until recently to obtain the funding under the 'Feed in Tariff' for solar photovoltaic panels (Ofgem, 2021).

It could be argued that EPC procurement does not lend itself well to impartiality, and a revised system of commissioning EPCs may be considered an appropriate avenue for further research. Furthermore, were any pressure brought to bear be proven, there would doubtless be no averaging out of such assessments so that results may form a reasonable 'mean' for high level analysis, so any such 'drift' (a term referenced by Kempton et al., 2001) of EPC data could give spurious results. The ramifications for this could be serious, as any large, or in fact small scale analysis of EPC data should it be affected this way, would be misleading. While these issues are noted anecdotally, they can be difficult to establish explicitly and further research would be required to point to this more robustly as a phenomenon. With only interview material forming the case study of this paper, this must be noted as a limitation here.

The level of experience and training for DEAs was considered inappropriate, given their increasing role. This contradicts an assertion made by Andaloro et al., (2010), where a high confidence rating is given to DEAs in the UK based on the training given. The interviewees reported that the training provided is too limited in scope and depth. Andoloro indicates that in many European countries, only experienced practitioners with a relevant professional qualification may take the training to

become DEAs. A number of the interviewees put forward a view that this should be the case in the UK. The short DEA training programme was considered insufficient by interviewees, when set against what is now expected of DEAs, and some understanding of buildings in a relevant capacity prior to training was considered a pre-requisite. It may also be reasonable to link limited training and experience to a poor public perception of EPCs.

Consumer trust and confidence in the quality of EPCs is low, both in the opinion of the DEAs and when referenced back to the literature: note in particular Banks (2008) who touched on a poor perceived value with a study that found a consensus among those commissioning EPCs that they constituted a 'stealth tax', and Watts et al. (Watts, Jentsch et al., 2011) who pointed to the interview data of recipients of EPCs where it was inferred little consideration was given to the EPC's contents when making the wider judgement of whether to proceed with their purchase. However, recent public views have not been assessed, and further research into the current public perception of the EPC may yield interesting results, especially given the increasing prominence of energy efficiency more generally in the public domain.

The literature points to the likelihood of increased take up of measures and trust in EPCs, if they were more carefully tailored to the property to which they pertain. Oxera (2008), Swan et al., (2017) and Chahal et al., (2012) all mention a need for more precise costing of energy efficiency measures within their research. This can be linked with the thoughts of the interviewees. For example, it may be possible to link basic schedules of rates with RdSAP inputs, so that estimates for improvements contained in the report could be more accurately based on quantities. This might be made easier if a more thorough inspection regime was undertaken.

In summary, we can see that variability between assessors as reflected upon by the respondents is driven by a number of issues outside of the standard variability, as noted by Kempton (2016).

- Knowledge of buildings meaning issues are missed or assumptions incorrectly made.
- Lack of knowledge of the EPC process and conventions.
- Incentives driven by the 'use' of the EPC may create a conflict of interest which in turn could direct DEAs towards certain results.

The first two of these may be addressed by changes to the way either the process is delivered, or support is given to the development of DEAs, or both. This can be addressed by either better training or better tools, which have the capacity to support and identify errors, such as the artificial intelligence approaches applied by Hardy and Glew, (2019) being more embedded within the tools used by DEAs to support decision making. The issue of incentives is more complex. Individual DEAs may rely on asset owners or their agents to make decisions that are beneficial to those individuals in order to continue working for them. This may be changed by making the DEAs independent of the asset owners when assessing properties to remove this incentive. However, this would be a significant change to market practice. These solutions are based on pre-assessment activities. However, the audit and management of data presents opportunities as well. Again, data analytics approaches, as identified by Hardy and Glew (2019), have the potential to focus audit resource where issues are

identified, and a further step may be to go to the field where issues are viewed as significant enough to warrant further exploration.

Finally, the results here inform other research papers where no such consultation with DEAs was carried out, but EPC variability was identified (Ahern & Norton, 2020; Hardy & Glew, 2019; Jenkins et al., 2019; Gledhill et al., 2016). With this research, a range of contextual factors are identified as having a bearing over the work produced by DEAs, and for the first time these are asserted to contribute to EPC variability *by those who produce them*. This may be considered an additional, and relevant component when documenting the technical variability calculated by authors studying the contents of EPC databases, which may serve to enrich the overall study area. Future research into EPC variability may take account of the matters brought to our attention by the respondents here, when considering the causes of variability, especially when drilling down into the variation nuances. This may add to the robustness of research conclusions drawn about variability in future. In addition, there are specific avenues for further research, in particular in regard to the unproven assertions about the commissioning of EPCs, the auditing process, and the level of EPC accuracy versus the level of experience of DEAs, all of which fell beyond the bounds of this paper's remit.

7.0 Conclusions

A fundamental part of the broad context of this paper is the ability to be able to measure the energy efficiency of a residential building accurately and consistently, so that progress against targets can be measured, current emissions can be calculated, and robust data can be used to formulate policy.

The social, political, and economic context of energy efficiency is significant, and becoming more so. Recent significant hikes in energy prices have increased the focus on energy efficiency in buildings. Arguably, this places the energy assessor's role in a more important position than ever before. The energy assessor's function provides scope for powerful and if accurate, very useful data which may be used for many purposes, from policy formulation to investment decisions. There is a marked shift from the EPC's originally intended function as a report that produces an energy rating to individual consumers, into a world where decisions rely increasingly upon EPC data. Given the scale and scope of the EPC database, it is unlikely that it will return to being an asset register alone. The EPC database has great value for a wide range of actors; both academic and professional, and the material from this research may be considered of interest when digesting the technical variability identified in research elsewhere, as well as feeding into future research in the study area, increasing the robustness of any conclusions drawn. With the ever-increasing quantity, coupled with the added scope and scale of EPC data, there is a correspondingly increased need to understand EPC variability and mitigate against the risk of misreporting. The research here aids this cause.

This research has identified issues for practice that should merit further investigation and may need to be addressed. The interview material clearly points to areas where the DEA may see and record things differently, and this provides scope for variability, potentially independent of the technical variability identified by research elsewhere.

While there is some considerable focus on the RdSAP model within existing literature, as well as the EPC report itself and its perception, there is very limited literature about DEAs and the surveying process. The purpose here has been to establish variability as a phenomenon, and attribute this at least in part to the surveying *process* – to the DEA, as opposed to the software model. Clear evidence for this, and any indication about its extent is yet to be established, and this will be the focus of further investigation.

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