Legislation, disincentives and low energy buildings:
Overcoming barriers in the design process.

CRAIG ROBERTSON[1], DR DEJAN MUMOVIC[2]

[1]UCL Energy Institute, University College London, London, UK
[2]Bartlett School of Graduate Studies, University College London, London, UK

ABSTRACT: The European Performance of Buildings Directive and the United Kingdom Climate Change Act have resulted in a range of measures aimed at lowering building energy consumption. In the UK the result of this legislation, guidance and incentivisation is often to reduce anticipated energy use rather than the consumption of the complete and occupied building. Building procurement is a complex interaction between a range of actors within a suite of legislation and guidance and financial, environmental, architectural, professional and social pressures. The combination of these factors is described in this study as the 'contextual pressures'. The contextual pressures are designed to incentivise or oblige designers to engage with building energy consumption but also contain disincentives like the fear of financial or legal liability.

This paper describes a mixed methods study that explores the way that actors working in industry interact with the contextual pressures; how they influence decisions and work patterns. A web based survey was carried out aimed at understanding which pressures have greatest impact on actors design thinking and whether this reflects their organisations' aspirations. 22 semi-structured interviews were then carried out to explore the processes that actors employ, the pressures that they feel most acutely and how this impacts on their design processes and resultant buildings.

The results of this study identify areas of the legislative framework that are in conflict with actor's aspirations and the macro-aims of lower carbon emissions and where actors feel that they are hindered in achieving low energy buildings.

Keywords: Design Process; Feedback; Legislative Framework

INTRODUCTION

European Union (EU) nations are bound by the Energy Performance of Buildings Directive (EPBD) to reduce the energy consumption associated with their building stock. The 2008 Climate Change Act (CCA) has committed the United Kingdom (UK) to delivering an 80% reduction in CO_2 emissions by 2050 relative to 1990 levels [5]. Energy used in buildings in the UK accounts for 45% of all UK carbon emissions; housing represents 27% and non-domestic buildings 18% [9].

Lord Stern argued that where the market cannot provide these reductions, regulation should be employed [17]. However, efforts to achieve significant energy and CO_2 reductions through legislation have reduced the anticipated energy and carbon dioxide emissions of building designs rather than the subsequent actual energy consumption [8].

Delivering the necessary reductions in the built environment is complex; the design, construction and management of buildings is not a simple set of economic interactions. The process is carried out by a multi-disciplinary project team – a 'socially regulated' network of decision makers [14].

This network of decision making actors (designers, contractors, developers etc) operates within a framework of incentives, legislation, economic drivers, professional aspirations and social pressures. Within this over-arching framework there are both project team obligations such as building regulation compliance and individual actor motivations such as the varying economic motivations associated with a commercial development [2]. Each actor also has broader professional responsibilities; decision choices are affected by this network of cultural, institutional, macro-social/economic and technical factors [3,14].

The PROBE (Post-Occupancy Review of Buildings and their Engineering) studies revealed that it is not uncommon for the actual energy use of a building to be two or three times that of a design prediction [4]. There is a complex network of reasons why predicted energy consumption is lower than recorded end use. These include incorrect assumptions used in design calculations, changes made to the building design during construction, a poor design, poor management of the finished building or a combination of some or all of the above and more [4].

Way and Bordass [19] identify using feedback (assessing buildings to learn from successful or unsuccessful designs or management strategies) as a means of understanding and overcoming some of the factors that lead to poor or unexpected energy performance. The literature describes a number of reasons why feedback information is not habitually collected and used to inform practice. These include a simple reluctance to pay for the evaluation to be carried out; Clients' general inability to see the benefit (financial or otherwise) as their building is 'finished'; a lack of engagement with the building occupiers on the part of commercial Clients; uncertainty about how to carry out an evaluation [19]; a perception that gathering evidence of a building not functioning as intended might expose practitioners to extra work beyond the scope of an initial appointment or even litigation [13]; a perceived lack of value in the information gathered; the commercial benefits are not perceived to match the outlay in gathering information [1]; finally, a practical issue: POE information is often published in places that are not often accessed by industry (such as academic journals) and practitioners are often left to use previous ideas again or reinvent things blindly [18].

This paper aims to answer four questions; which of the contextual pressures do actors consider important to their organisations? How are project energy targets defined? What are the significant barriers to engaging with feedback? How could these barriers be overcome?

METHODOLOGY

A mixed methods approach has been used, *'combining qualitative and quantitative approaches so that the overall strength of the study is greater than an individual method'* [7]. The current study used three phases; a document analysis and participant observation, an internet survey and a series of semi-structured interviews. The subject of the study is construction industry actors generally; all actors working in all sectors including domestic buildings.

First, the document analysis and two forms of participant observation were carried out by the main author. Participant observation is a method of data collection often used as part of ethnographic studies as a means of immersing a researcher in the culture, routines and activities of the subject population [6, 10]. In this case it was used to define the contextual pressures.

Second, an internet survey was used with a question set designed to understand the relationship between industry decision making and the contextual pressures. Questions were mostly multiple choice often using a Likert rating scale. They were themed around 5 subjects: the respondents role and organisation characteristics, the kind of work respondents were involved in, how design and management stage energy targets were chosen and the process of working to meet them, what data was collected in order to assess projects and finally what kind of risks actors felt most impacted on their work.

Third, a series of follow up semi-structured interviews were carried out. The quantitative data collected by the online survey inevitably left gaps in the understanding of the studied process. The responses generated a range of categorical data; the semi structured interviews used a similar range of industry actors and aimed to fill the gaps in this data and elaborate on actors thinking. The survey provided an overview of actors behaviour within the contextual pressures, interviewing aimed to give understanding, meaning and context to this data [16].

SAMPLING AND DATA COLLECTION

The target population was UK construction industry professionals. The survey used two sampling strategies; a list frame and an area frame. The list frame used the Chartered Institute of Buildings Services Engineers (CIBSE) School Design Group membership list (CSDG) and the area frame comprised all Royal Institute of British Architects (RIBA), CIBSE and British Institute of Facilities Mangers (BIFM) registered organisations in London. The two approaches have different characteristics; the CSDG is an existing group of self-selected individuals and contact was made directly to individual's email addresses. The London area frame (LAF) email addresses were taken from public domain websites and therefore had no self selection bias but were company email accounts, often administrative addresses rather than individuals. According to Dillman [11] a small incentive can improve the response rate, therefore addressees were encouraged to complete the survey through entry to a draw to win an MP3 player or a copy of an environmental design book.

The semi structured interviews were carried out as a follow up to the survey and explored the same themes in greater detail [16]. Initially, contact was made with survey respondents who had indicated they were willing to take part in further research; of the 22 interviews carried out, 4 had filled in the online survey. The rest were contacted through a sampling strategy determined by two considerations; the first practical consideration was that access was required to the participants for a face to face interview; the second was the purposeful selection of appropriate participants to fill in gaps in the data [12]. This sampling strategy could be summarised as an initial phase of interested and accessible participants followed by a targeted approach of particular actors.

Figure 1 shows the Construction Industry Council's (CIC) survey of employment in the construction industry professions compared to the survey and interview samples [15]. Both the survey and interview samples have just over half of respondents in architecture or engineering, the survey split showing predominantly engineers and the interview sample showing predominantly architects. The CIC survey shows around half of each. Neither the survey or interview sample has any surveying professionals, whereas the CIC survey shows over 20% of respondents identified as part of this profession.

The combined total survey sample comprised of 503 respondents across 11 defined organisation types illustrated in Figure 2. 29% of the respondents worked in 'Services Engineers' and 21% of respondents worked in 'Architectural Practices'.

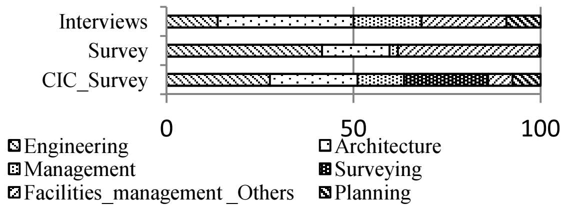

Figure 1 Survey and interview samples and industry survey.

. The next largest group was those working in 'Multi-Disciplinary Practices' followed by those in 'Other' organisation types. 'Other' organisation types included 15% of the category in 'Local Authority', 12 as 'Education', 7% worked in 'Manufacturing', 5% worked in 'Energy Consultants', 4% in 'Academia' and 4% in 'Central Government Agencies'.

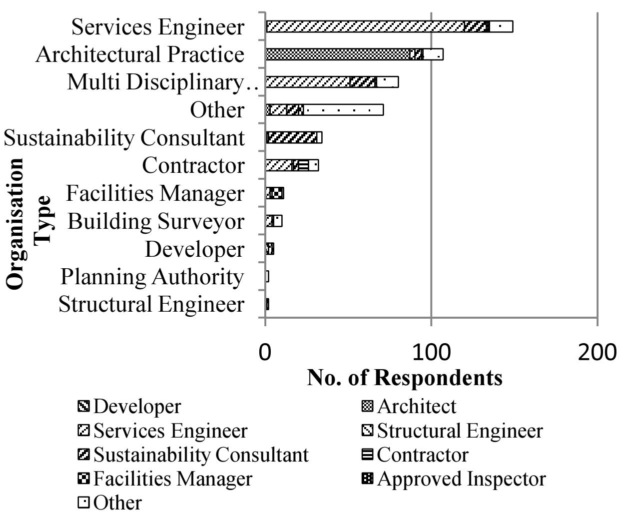

Figure 2 Survey sample by organisation and respondent type.

Respondents' roles were not necessarily defined by their organisation; 41% of respondents defining their role as 'Services Engineer', 12 percentage points more than working for purely service engineering organisations. 18% of respondents identified their role as 'Architects', 3 percentage points less than working in architectural practices.

RESULTS AND DISCUSSION

The first survey question analysed in this paper asked respondents to 'Rate the importance of each of the following to your organisation', offering a range of factors. Table 1 shows the factors and ranked mean scores for responses. 'Organisation Reputation' is close to a maximum mean score of 5. 'Occupant Satisfaction' and 'Energy Consumption are also considered of high importance to respondents' organisations.

Table 1 Mean scores for importance of individual factors.

Factor	Mean Score	Ranking
Organisation Reputation	4.74	1
Occupant Satisfaction	4.30	2
Energy Consumption	4.12	3
Building Capital Costs	4.04	4
Sustainability	4.02	5
Building Running Costs	3.93	6
Carbon Emissions	3.84	7
Architectural Design	3.63	8
Other Factors	2.46	9

Figure 3 shows detailed breakdowns of the responses to question 1. Approximately 70% of respondents answered 'Organisation Reputation' was 'Extremely Important'. Approximately 55% considered 'Occupant Satisfaction' 'Extremely Important' and is arguably connected to reputation. 'Architectural Design' was 'Extremely Important' to the fewest respondents and also scored the lowest mean rank. Energy consumption was considered of some importance to all respondents and 'Extremely Important' to around 50%. 'Carbon Emissions' were considered 'Extremely Important' by 40%. 'Other Factors' included the 'cost of energy', 'fuel poverty', 'whole life costs', 'building quality' and 'ecology'.

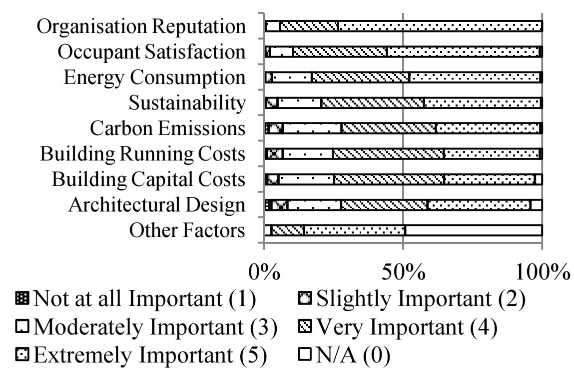

Figure 3 Importance of factors to respondents' organisations.

Interviewees' regard of what was important to their organisation was often driven by their role. Developers were interested in carbon and designers were often more interested in energy. The idea that current policy was not focussed on the right people was cited by and engineer and policy makers. A local authority policy maker indicated a shift to fuel poverty driven policy while a recent review of policy by a central government department led one policy maker to state *"the drive for a carbon target was actually a complete distraction from energy…you know building regs are energy efficiency but not energy management or...buildings physics"*. This reflects the discrepancy in the importance of carbon and energy identified by the survey.

Often interviewees quoted 'doing the right thing' as one of their drivers and expressed frustration with the way legislation was framed. An engineer working for a development company expressed both his desire to reduce the environmental impact of his company's buildings but also frustration with policy; he said *"we think it is a good thing that needs doing [but] the government and policy makers are asking the wrong people to deal with the problem."*

Almost all interviewees cited costs, whether fees and profits, capital investment or running costs as important factors to their organisation and to their projects. Cost is the basis of discussions in design, construction and management; carbon does not seem to be a natural part of the conversation.

Figure 4 shows the importance of 'Energy Consumption' to individual actor groups. Approved Inspectors and Facilities Managers consider this the most important of all respondents. Structural Engineers and Architects consider 'Energy Consumption' the least important. This perhaps reflects that Services Engineers are often responsible for energy compliance calculations whilst architects are responsible for other factors in the design process.

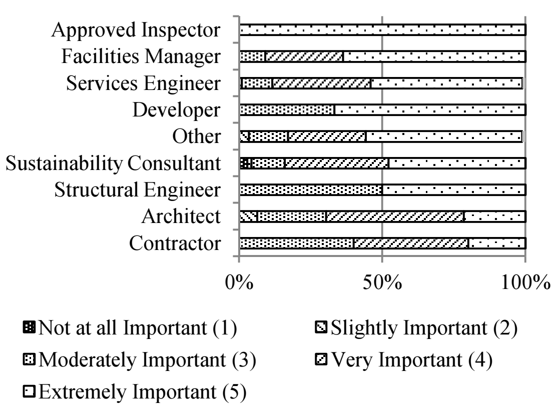

Figure 4 Importance of 'Energy Consumption' to respondents.

The second question analysed asked 'What are the main drivers is setting project energy targets?' The ranked mean scores are illustrated in Table 2. 'Client Goals' are the most important factor in defining project energy targets followed by 'Mandatory Targets' and 'Planning Requirements. The least important drivers were 'CIBSE Benchmarks' and 'Personal Goals'.

Table 2 Scores for factors influencing project energy targets.

Factor	Mean Score	Ranking
Client Goals	4.33	1
Mandatory Targets	4.26	2
Planning Requirements	4.10	3
Familiarity with Targets	3.96	4
Other Targets	3.73	5
Organisations Goals	3.71	6
Personal Goals	3.42	7
CIBSE Benchmarks	3.12	8
Other Factors	1.60	9

Figure 5 shows a detailed breakdown of the responses. Approx. 60% of respondents indicated 'Mandatory Targets' (including building regulations) as 'Extremely Important'. 'Client Goals' are considered 'Extremely Important' by around 55% of respondents. 'Familiarity with targets' is considered 'Extremely Important' when setting targets by 30% of respondents. Around 10% of respondents indicated that 'CIBSE Benchmarks' are 'Not at all important' and 15% thinking them 'Extremely Important'.

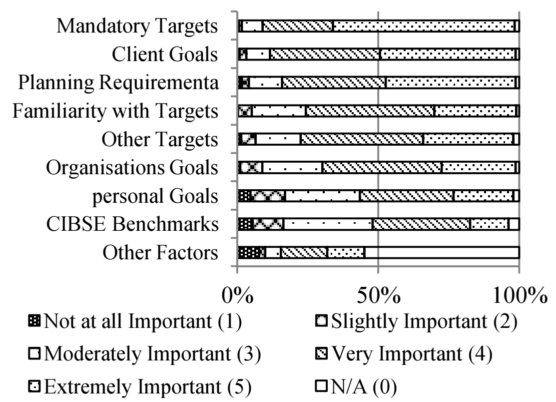

Figure 5 Importance of factors determining energy targets.

Interviewees also cited mandatory targets as the most common means of determining project energy targets. While this suggests a lack of leadership from industry some actors felt that building regulations and often more stringent targets set by BREEAM standards meant that clients were forced to engage with energy. One architect said *"to some extents BREEAM is helping architects achieve what you'd like to achieve anyway…because someone's setting you these high targets…of BREEAM* *or LEED ratings, you've got that in your pocket to kind of say well, 'we need to do this'".*

Formal targets have a dual role; ensuring that all buildings meet a minimum standard but also helping those with more ambition to persuade clients to invest in a better building.

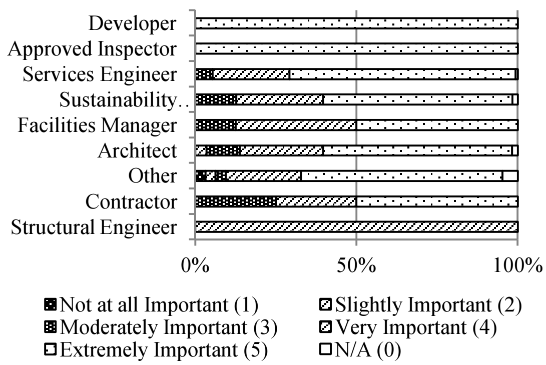

Figure 6 Importance of 'Mandatory Targets'.

Figure 6 shows the importance of 'Mandatory Targets' to individual actor groups. 'Mandatory Targets' were most important to 'Developers', 'Approved Inspectors' and 'Services Engineers' and least important to 'Structural Engineers' (who have little responsibility for energy) and 'Contractors'.

Table 3 Mean scores of disincentives.

	Mean Score	Ranking
Cost to Organisation	3.02	1
Client cannot see the benefit	3.15	2
Difficulty accessing buildings	2.82	3
Cost to Clients	2.71	4
Inexperience in POE	2.56	5
Organisation cannot see the benefit	2.14	6
Concern over liability	2.27	7
Other	1.56	8

Question 3 asked respondents to 'Rate the following in terms of disincentive to you collecting energy data from finished buildings or managed property'. Table 3 shows ranked mean scores for this question. The strongest disincentive to respondent was 'Cost to Organisation' followed by 'Client cannot see the benefit'. The lowest ranked reasons for not collecting energy data from finished buildings was 'Concern over liability' and 'Organisation cannot see the benefit'. This suggests a desire to learn from buildings hampered by a lack of money or client will to facilitate it.

Figure 7 shows detailed breakdown of responses to question 3. 45% of respondents indicated that 'Cost to your organisation' is a 'Complete' or 'Strong disincentive', 12% stated it is a 'Complete disincentive'. 44% of respondents indicated that 'Cost to Clients' is a 'Strong' or 'Complete Disincentive', 12% of respondents consider it a 'Complete Disincentive'. 'My organisation cannot see the benefit' is viewed as 'No disincentive' by the highest proportion of respondents, 33%. 26% view 'Concern over liability' as no disincentive.

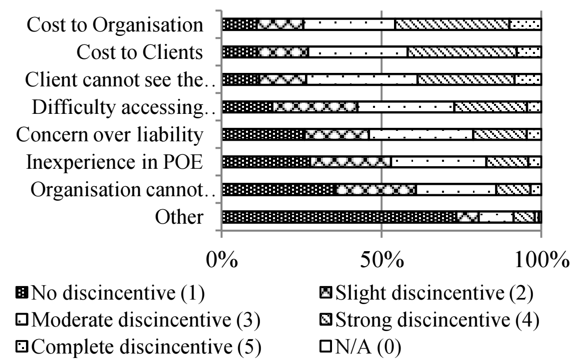

Figure 7 The perceived disincentive of various factors.

Interviewees indicated a similar set of barriers: costs and reputational concerns and also expressed concern over liability although often they were unable to cite specific examples. An engineer talked of the conflict between the desire to carry out post occupancy evaluation for the marketing opportunity and perceived risk: *"...it's kind of a double edged sword, it could brilliant or the client could turn round and say well hang on you haven't given us the flipping building we paid for!"*

The lack of contractual necessity, monetary incentive or access to buildings all mean that designers do not often carry out formal evaluations. Those that could overcome these barriers tended to be those working on the client side; they have a financial incentive and ongoing access to their own buildings.

CONCLUSION

The contextual pressures deal in carbon emission targets. The data suggest that the common language of the design and procurement of buildings is costs: fees, capital expenditure and running costs. Carbon is seen by some as abstract and does not address the fundamental issues of management, efficiency and building physics. Relating legislation and targets more directly to costs may be a way of engaging more of industry with the issue of energy and carbon emissions.

Building Regulations are most often the way that project targets are set. Non-mandatory guidance and certification schemes such as BREEAM can be used as a lever by designers to encourage reluctant clients into investing in their buildings. The key actor able to apply this lever may change throughout the process; it may be the architect at design stage, the contractor at construction and the occupier in the completed building.

While formalised targets are important to ensure minimum standards, it has been suggested that they may force actors to take measures they would not consider beneficial, potentially damaging reputations. There is a tension between mandating minimum standards whist allowing others the freedom to innovate. An increased incentive for more innovative thinking might encourage actors to go beyond the minimum standards.

The barriers to carrying out POE found in the data are costs, liability and difficulty accessing buildings causing a tension between actors' desire to engage with energy and the perceived risks associated with this. Reducing the perceived risks like liability or reputational damage and enhancing the benefits may lead to greater reductions in energy consumption.

There are two main areas of opportunity to utilise existing pressures to motivate actors: linking cost and profit benefits directly to energy targets and stimulating a reputational benefit associated with well performing buildings. Using costs could be a simple way of linking interests across a project team, ensuring that a common metric was used throughout the process. Explicitly connecting the reputation of firms and individual actors to the performance of buildings could engage actors more fully with energy. Mitigating the fear of litigation or reputational damage is fundamental to achieving this. Aiming this kind of policy at key actors may also incentivise some to try and go beyond the minimum standards and gain the reputational benefit of a well performing building.

In order to develop these embryonic ideas for policy change some further analysis needs to be carried out on the current data set. The different roles an actor plays in the procurement process may influence their attitude to energy may be important factors in targeting policy. Similarly different building sectors and funding methods may require a different approach.

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