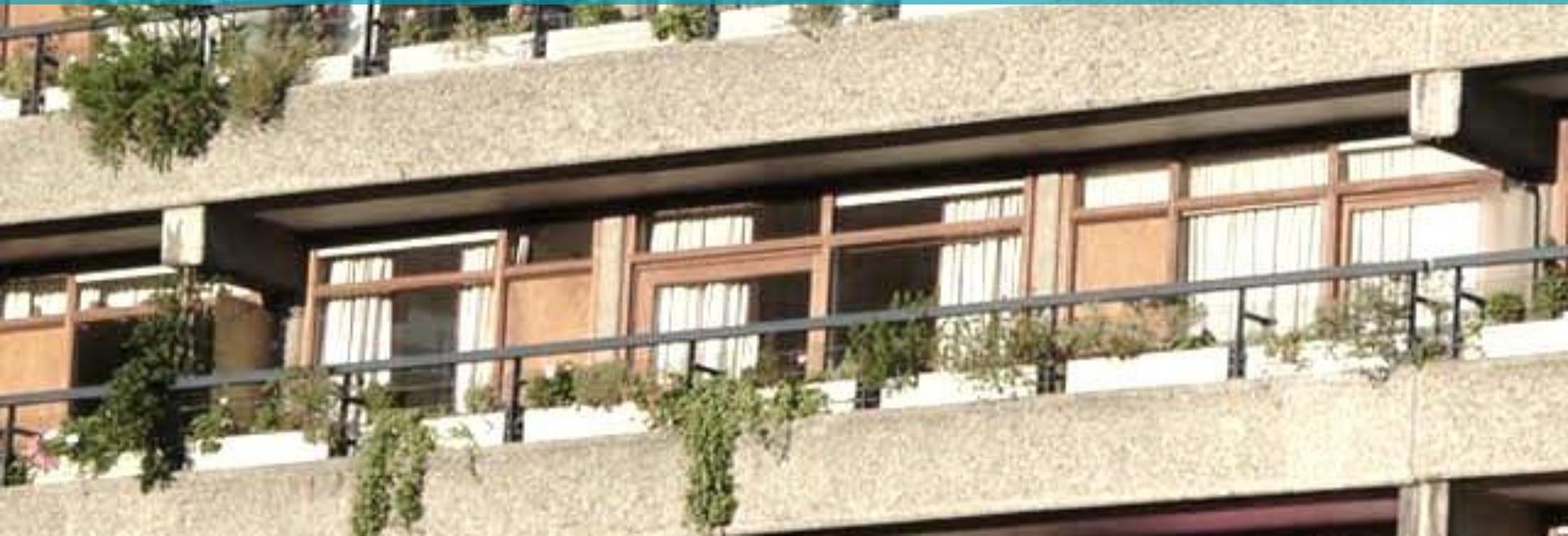


UCL ENERGY INSTITUTE



Post-Occupancy Evaluation of Barbican Centre Dwellings

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Aim of Presentation

- Describe process of academic research
- Share key outputs of the work for academia and industry

Structure

- Introduce research area and context
- Research questions
- Describe case study site
- Overview of methodology and research methods
- Results of POE study
- Discuss implications of findings
- Further work

Introduction

- Project located in the areas of building performance evaluation and occupant behaviour in domestic buildings

Context

- Reducing UK domestic energy demand
- Mitigate against effects of anthropogenic climate change
- Growing recognition of performance gap between predicted and actual energy use, as a result of people and behaviour
- What to do with those buildings that do not lend themselves to fabric interventions? (e.g. iconic and listed buildings)

Case Study Site: The Barbican Centre



- Mixed-use cultural and residential site in Central London
- Designed and constructed in the 1960's
- 2056 residential units (mostly flats)
- Grade II listed buildings and landscaping
- Active residents community with sustainability group



Building Fabric

- Solid concrete construction
- Timber-framed single glazing
- No insulation
- Thermal bridging prevalent

Heating

- Electric underfloor heating is centrally controlled
- Adjusting trimmers and removing fuses only way to control heating
- Poor energy performance (average heating energy-use is 194kWh/m²/y; *well* above best practice)

Research Questions

1. How well do the residential areas of the Barbican Centre perform in terms of design, lighting, noise, thermal comfort and perceived personal control, and how do these results compare to benchmark data from other UK housing projects?
2. How can we improve the energy performance of the Barbican, given its status as a Listed Building and the age of its heating system?
3. How effective is POE as a diagnostic tool for characterising baseline user satisfaction, energy use and behaviour, as well as in identifying treatable problems and solutions at a case study site?

Methods

- qualitative and quantitative questions
- 19.2% response rate

POE study of Barbican

Occupant questionnaire

Evaluation of heating energy performance

- BUS Methodology (Leaman)
- Behaviour survey (Gill)
- Heating and cooling control (after consultation with residents group)

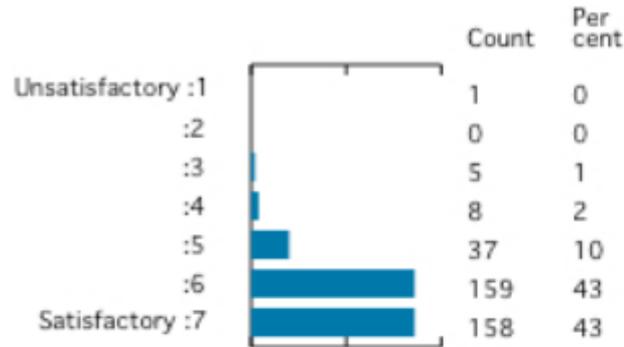
- Heating energy consumption by block data available for the years 2002/03 to 2008/09

Results of BUS questionnaire

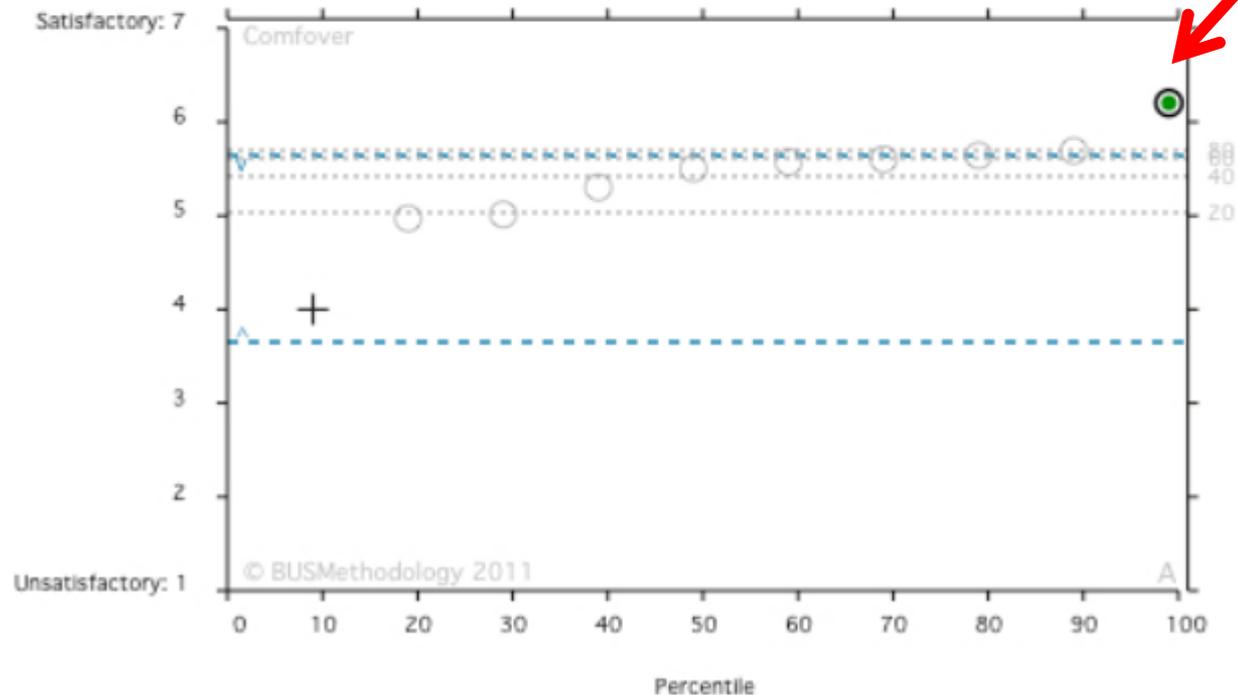
Variable	Average Score	Standard Deviation	Scale
Air in Summer: Overall	5.52	1.36	Unsatisfactory : Satisfactory [1-7]
Air in Winter: Overall	5.26	1.54	Unsatisfactory : Satisfactory [1-7]
Comfort: Overall	6.23	0.87	Unsatisfactory : Satisfactory [1-7]
Design	5.82	1.2	Unsatisfactory : Satisfactory [1-7]
Health (Perceived)	4.47	1.35	Less Healthy : More Healthy [1-7]
Lighting: Overall	5.49	1.52	Unsatisfactory : Satisfactory [1-7]
Needs	6.09	1.01	Very Poorly : Very Well [1-7]
Noise: Overall	5.23	1.76	Unsatisfactory : Satisfactory [1-7]
Temperature in Summer: Overall	5.42	1.52	Uncomfortable : Comfortable [1-7]
Temperature in Winter: Overall	5.25	1.64	Uncomfortable : Comfortable [1-7]

- Overall satisfaction high but:
- dry air all year, variable temperatures and lack of heating and noise control were found to be significant problems
- 69% said that living at the Barbican had changed their lifestyle

Typical BUS Screenshot: Overall Comfort

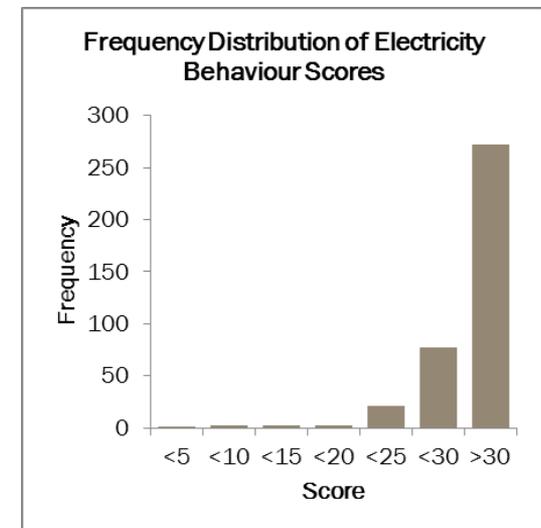
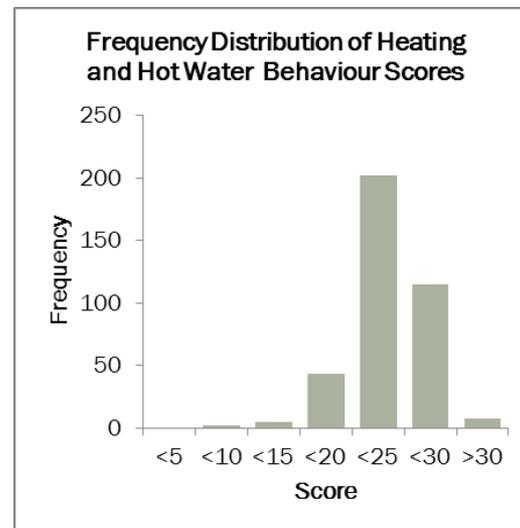
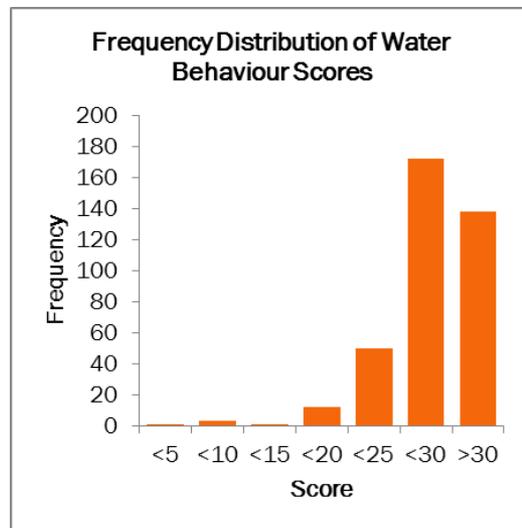


Barbican



Results of Behaviour questionnaire

- Scores are high suggesting energy efficient behaviours and high environmental awareness at the Barbican
- However, inadequate benchmark data to back up this claim
- Comparison across site shows slightly higher average scores in the towers than other areas



Results: BUS, Energy-use, Behaviour

- Test for relationships between BUS and behaviour scores and heating energy consumption
- **No correlation** between BUS scores and energy consumption
- **No correlation** between BUS scores and behaviour
- **No correlation** between behaviour scores and energy consumption

Results as predicted for a set of **buildings where residents do not have individual control** over heating

Results: Heating Controls

- Windows and ancillary heaters most popular heating strategies
- Trimmers and fuses only used by a small number of people
- 89% of respondents use windows to control the heating
- **X² : People who use trimmers are significantly less likely to open the windows to control the heating (p=0.04)**
- **T-test: No significant difference in comfort between people who use trimmers to control heating and those who don't (p=0.4, 0.5, 0.9)**
- Almost half of residents unaware of option to adjust trimmers

Opening windows during winter wastes energy, therefore, results suggest that **if more people used the trimmers energy savings could be made.**

Key Findings

- Buildings are performing well overall- heating control, dry air and variable temperatures only major problems
- Hard to characterise behaviour as we do not have individual energy consumption data for the flats, only block averages. Overall behaviour scores appear quite high (although lack of benchmarks)
- Question about heating and cooling control particularly interesting- evidence that people are trying to regain the control that has been taken away from them- windows / trimmers / ancillary heating

Recommendations

- Recommendations are made to spread awareness about how the trimmers and fuses can be adjusted to optimise heating
- Need for systematic appraisal and adjustment of trimmers across the site to improve energy efficiency and reduce heating costs
- High behaviour scores suggest that people will be responsive to the intervention
- No evidence that this will reduce the high overall satisfaction presently perceived by residents (good news for us!)

POE as method?

- POE used effectively as a diagnostic tool to solve specific problems
- Combination of BUS and behaviour questions useful as it allowed us to identify areas of satisfaction and dissatisfaction

BUT

- Critical question about heating and cooling control was added after review with residents and is site specific
- ‘One size fits all’ POE method might not be best solution for this kind of building

Further Work

- Residents are currently piloting our recommendation to optimise the heating controls in one of the blocks
- They will monitor heating energy use before and after to quantify how much energy could be saved through this relatively simple and low cost intervention
- Hopefully our work will result in real life energy savings- Watch this space for results!



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**Thank
you!**

Any Questions?