The Effectiveness of Installation and Commissioning Processes in Delivering New Mass Low Carbon Social Housing

Presentation by Dr Terry Keech B Eng(Hons) C Eng PrD MCIBSE MEI MIET
CONTENTS

• Introduction
• Framework for Research
• Research Scope and Methodology
• Industry Makeup
• Commissioning Process
• Findings
• Conclusions
• Future
• References
INTRODUCTION

Performance of low carbon homes is failing on a number of levels, indicating that ‘design’ and ‘as built’ construction vary considerably (Zero Carbon Hub, 2011). Beliz Ozorhon (2016) identifies that quality and process is underperforming, giving cause for concern in the construction industry’s response to housing low carbon challenges. My research investigated aspects of this underperformance witnessed through practitioner engagement on low carbon housing projects.
FRAMEWORK FOR THE RESEARCH

1. Regulation and Assessment
   - Building Regulations
   - SAP Assessment
   - Code for sustainable Homes

Performance of low carbon technologies

2. Process
   - Installation
   - Commissioning
   - Handover
   - Defects

3. Experience and skill of construction professionals for low carbon homes (Tacit - Explicit Knowledge)

7. Approach for delivery of low carbon technologies

6. Construction cost and programme

5. Relationships Between Main contractor and subcontractor

4. Communication between construction professionals
RESEARCH SCOPE AND METHODOLOGY

• The performance of new build low carbon dwellings is a substantial subject area with a considerable quantity of literature and research concentrated on post occupancy behaviour and technology operation. There is much less research focused on training and commissioning of the technologies at the construction stages, with most of the research based on commercial buildings. Hopkins et al (2017) point to the apparent silence on the subject for UK housing development, recognising the need for the capture of the link from installation and commissioning to handover of the development.
• Data gathering has been achieved through the use of questionnaires, in-depth interviews and site observations.
• The questionnaires were circulated to over 600 contacts with a return of 255 respondents giving a return rate of 42.5%.
• Questionnaire surveys were enhanced by in-depth semi-structured interviews with a number of the construction professionals that had completed the survey, and site observations and interventions.
The Construction Statistics Annual Tables show the UK registered construction companies in the third quarter of 2014 (Office for National Statistics, 2015). These indicate that the employee make-up of the 66,533 Building Services construction companies, split into Electrical, Plumbing and Heating Ventilation and Air-conditioning (HVAC), operating within the UK are as follows:

**INDUSTRY MAKE UP**

The Construction Statistics Annual Tables show the UK registered construction companies in the third quarter of 2014 (Office for National Statistics, 2015). These indicate that the employee make-up of the 66,533 Building Services construction companies, split into Electrical, Plumbing and Heating Ventilation and Air-conditioning (HVAC), operating within the UK are as follows:

**M&E Contractors in the UK**

- More than 25 employees: 44%
- 14 - 24 Employees: 52%
- 2 - 13 Employees: 2%
- Sole Traders: 2%
Noyne et al (2013) identify the five primary steps to the commissioning process, with Level 3 being the predominate level, and Levels 4 and 5 rarely used.
FINDINGS – PARTICIPATION IN THE STUDY

Fig 2

Respondents

<table>
<thead>
<tr>
<th>Number of Respondents</th>
<th>Design</th>
<th>Developer/HA/PM</th>
<th>Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondents</td>
<td>66</td>
<td>102</td>
<td>58</td>
</tr>
</tbody>
</table>

Fig 3

Responsibility Level of Respondents

- Trainee level: 24%
- Graduate level: 16%
- Junior level: 15%
- Intermediate level: 19%
- Senior Technical: 2%
- Site Management: 2%
- Senior Management: 12%
- Project Manager: 2%
- Director: 2%

0%
## FINDINGS – EXPERIENCE

### Experience of Low Carbon Technologies Currently Used

<table>
<thead>
<tr>
<th>Technology</th>
<th>No experience</th>
<th>Little Experience</th>
<th>Experienced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Photovoltaic (Solar PV)</td>
<td>12</td>
<td>84</td>
<td>111</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>42</td>
<td>97</td>
<td>66</td>
</tr>
<tr>
<td>Ground Source Heat Pump (GSHP)</td>
<td>91</td>
<td>92</td>
<td>24</td>
</tr>
<tr>
<td>Air Source Heat Pump (ASHP)</td>
<td>55</td>
<td>99</td>
<td>53</td>
</tr>
<tr>
<td>Wind Turbine</td>
<td>159</td>
<td>41</td>
<td>7</td>
</tr>
<tr>
<td>Communal Heating (CHP)</td>
<td>40</td>
<td>77</td>
<td>90</td>
</tr>
<tr>
<td>MVHR (1)</td>
<td>32</td>
<td>71</td>
<td>104</td>
</tr>
<tr>
<td>Passive Building (2)</td>
<td>25</td>
<td>115</td>
<td>66</td>
</tr>
<tr>
<td>Biomass</td>
<td>75</td>
<td>90</td>
<td>41</td>
</tr>
</tbody>
</table>

*Fig 4*
The questionnaire identified key areas with regards to training and education in low carbon technologies. Figures 5 and 6 indicate that there is a low level of formal qualification in the survey group, whilst the main form of knowledge transfer is short duration seminars and ‘in house’ staff led seminars.
FINDINGS – FORMAL / INFORMAL KNOWLEDGE

The chart illustrates that practical information from the stakeholder organisation and site experience are the two main areas identified in the survey.

What is evident from the responses is the perception that monitoring of low carbon technologies is uncommon within the installation process (74.4% of respondents).
FINDINGS – COMMISSIONING

Gaps highlighted in commissioning indicate that the process is considered disjointed and lacking co-ordination, with validation by the designer as the least engaged area of commissioning.

Considering that most low carbon technologies require a higher degree of co-ordination with the building and other building services to operate effectively, the deficiencies observed indicate a serious concern for efficient performance of the technology.

Fig 9
FINDINGS – EFFECTIVENESS

Figures 10 and 11, where the survey asked questions on the effectiveness of the commissioning and the subsequent occurrence of defects during the defect period. There is a noticeable level of opinion that suggests its effectiveness is lower than should be expected for low carbon performance. When this is read in conjunction with the incidence of defects a distinct pattern is observed from failing commissioning processes through to the direct operation of the technology by residents.

Fig 10

Commissioning is carried out effectively on site
FINDINGS – DEFECTS

Where complex technologies are being used for low carbon housing, the higher rate of defects could be related to the extended ‘undeclared post-handover’ commissioning of the installed system.

Commissioning is continuing long after the building is handed over, hidden within defect rectification, as Lohne et al (2016) suggests ‘fuzzy commissioning’. Consequently uncoordinated commissioning is taking place whilst the residents are living in the dwelling. In this way, dependent on the level and duration of the intervention, the resident perceives the technology to be faulty and subsequent trust in operation is lost at the important early stage of occupation.

Only 2% stated less defects
FINDINGS – BARRIERS

Barriers identified as installation standards; challenge to performance and actual performance not assessed at completion.

<table>
<thead>
<tr>
<th>Pre-intervention Barriers</th>
<th>Traits of the Barriers</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No monitoring of the installation and commissioning</td>
<td>Poor installation standards</td>
<td>System becomes inherently inefficient within the building structure, therefore, possess long term performance issues</td>
</tr>
<tr>
<td>2. Limited Knowledge across the construction teams for the low energy and carbon installation</td>
<td>Inability to challenge performance standards</td>
<td>Early stage, high level challenge is not carried out and team do not understand the implications of underperformance of the system</td>
</tr>
<tr>
<td>3. No process link between the assessment performance and the actual performance of the system</td>
<td>Actual performance not as assessed performance</td>
<td>No structured process in place to control each stage of the system performance requirements, from design to completion, therefore, a cyclical return to item 1.</td>
</tr>
</tbody>
</table>
FINDINGS – INTERVENTIONS

Process adopted for Intervention Cycles:

- **Barrier 1**
  - No monitoring of the installation and commissioning

- **Barrier 2**
  - Limited knowledge for the low energy and carbon installation

- **Barrier 3**
  - No process link between assessment performance and actual performance

**Barrier Traits:**
- Poor installation standards
- Inability to challenge performance
- Actual performance not as assessed performance standards

**Action Cycle 1**
- Set up monitoring process S1, S2 and S3

**Action Cycle 2**
- Set up training session with stakeholders S1, S2 and S3

**Reflection on Action**

**New Working Practice**
- Commission2 Work

Fig 13
FINDINGS – INTERVENTIONS

Process adopted for Intervention Cycles:

*Fig 14*
SAP 10
• Mains Gas and Electricity are now much closer suggesting that Heat Pumps will possibly become more prevalent for residential schemes.

• Building Regulations – Part L1B (Existing Building) amended 2018 (latest edition of the Domestic Building Services Compliance Guide)
• Part L1A – still awaiting confirmation of new edition (also when SAP 10 comes into force).

Grid Watch October 2018
REFERENCES


REFERENCES

- Annual ARCOM Conference, 7-9 September 2015, Lincoln, UK, Association of Researchers in Construction Management, 1073-1082.
THANK YOU