SOLID WALL INSULATION RETROFIT IN UK DWELLINGS: CRITICAL FACTORS AFFECTING MANAGEMENT AND QUALITY

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Driven largely by government policy instruments, the UK solid wall insulation (SWI) industry today is experiencing explosive growth rates. This research explores critical factors in the industry's efforts to overcome a legacy of poor design and build quality in retrofit work. The research employs qualitative and ethnographic methods across a range of UK area-based retrofit projects and installer training programmes. It includes participant observation made while working in the role of SWI installer, and an extended study of a leading SWI installation company and its construction management processes. Findings identify patterns of 'short-termism', financial pressure, limited technical understanding, and point to immature management practices as recurrent impediments to installation quality. The research argues that in the context of a social-technical-political environment which hinders attainment of quality, new approaches to management are needed in the SWI industry.

Keywords: retrofit, quality, policy, training, organisational culture

INTRODUCTION

'Solid wall insulation' (SWI) refers to insulation applied to the internal or external face of an exterior solid or 'hard-to-treat' cavity wall. Recent rapid growth of SWI retrofit in the UK have been driven in large part by several government policy instruments. Statistics suggest that the total number of installations in the UK roughly doubled between mid-2011 and mid-2013, and roughly tripled from early 2009 – growing at approximately 30 per cent to 45 per cent per annum. Despite this, the latest estimates suggest there is considerable work to be done; of the 5.3 million homes without cavity wall insulation, 4.6 million are hard-to-treat. Meanwhile, approximately 3 per cent of roughly 7.8 million solid wall homes have been insulated. SWI represents a niche component in UK construction with the total number of SWI installations in the UK only recently exceeding 200,000. (DECC 2012; 2013)

Installation work is widely carried out by SMEs, which in turn often subcontract to small and micro enterprises in what are essentially design-build contracts (the requirement for 'design' in SWI is limited to 'buildability workarounds' to manufacturers' standardised installation specifications). Against a history of limited take-up (and low rates of innovation), the SWI installation industry today is a highly

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fragmented group of actors with a legacy of varying build-quality and appropriateness in specification practices and generally immature construction management practices.

Poor installation or specification of SWI retrofit presents significant risks of unintended consequences. These include interstitial and surface condensation, impacts on indoor air quality, moisture ingress, vapour build-up, and excessive summertime internal air temperatures (May and Rye 2012). These risks are significant to performance gaps, integrity of existing fabric and hazards to occupant health. Mitigation of the risks requires that installers have appropriate levels of skill and understanding, and work within a system of effective construction management.

This research is situated in the context of today's rapidly growing SWI installation industry, and the imperative to limited unintended consequences due to poor practices. It develops understanding of the key drivers of, and obstacles to, appropriate practice. It adopts a 'bottom-up' inductive approach based on qualitative methods. Findings are interrogated against existing theory, and analysed to develop new understandings.

LITERATURE REVIEW

The critical factors that impinge on design and build quality are too many to discuss in detail here. However, it is worth summarising the key points of theoretical context on topics such as quality, knowledge and skills, management and communication.

'Quality' in construction

The risks presented by poor installation and specification make clear that there is a need for the industry to improve quality in these processes. 'Quality' is a multidimensional concept in construction. Lavender (1996: p.284) argues that *"there is often a misunderstanding... It does not necessarily mean something which is good. Rather, it means conforming to a standard or requirement which has been set or which is expected"*. Harris and McCaffer (2013) reason that it reflects processes of organisation, production and pre-production dynamics, and they add attributes such as 'respect for people', 'continuous improvement', and 'response to change'. Increasingly, authors' definitions blur distinctions with 'quality management' and industry thought leaders imbue 'quality' with aspects of process and conformance.

Knowledge, skill and 'doing' work

Securing better 'quality' will rely on developing consistent technical understanding and skill across the industry. This will require support for knowledge exchange pathways and mechanisms through considered management strategies. The distinctions between 'tacit' and 'explicit' knowledge made by Nonaka and Takeuchi (1995) are useful in understanding the dynamics of construction and its management. In design circles, Donald Schön popularized the notion of *reflection- in-action* (1991); borrowing the term 'tacit knowing' from Polanyi (1958), he asserts that we know more than we can say. The acknowledgement of 'know-how' as a form of knowledge that differs from 'knowing-that' and the claim to primacy of practical knowledge is found in Polanyi and Dewey (1922: pp.177-8). This tacit knowledge can never be fully articulated and is characterised by Schön as *knowing-in- action*. Schön notes, *"although we sometimes think before acting, it is also true that in much of the spontaneous behaviour of skilful practice we reveal a kind of knowing which does not stem from prior intellectual operation"* (1991: 51). Improving exchange of explicit and knowledge between actors is vitally important and will benefit from significant investment in structured approaches (Robinson, *et al*. 2005).

Individual knowledge can be contrasted with organisational learning, which occurs in networks, or in 'communities of practice'(Wenger 1998). Expansive literature has already outlined organisational learning models (e.g. Bell, *et al*. 2002), and many authors have studied their application to the UK construction industry (e.g. Tennant and Fernie 2013). Little study to date has examined their relevance to the SWI industry.

'Doing good work' and 'abilities to do' are distinct concepts. Beyond 'know-how' and 'know-that', there are knotty issues of motivation and quality. These are discussed in Richard Sennett's work on craftsmanship (2009). Sennett (pp. 244-246) recognises that quality 'becomes an issue' and is internalised to create 'quality-driven' cultural norms. For instance, while observing 'obsessional energy' in the sushi chef and the electronics manufacturer, he notes that perfect consistency and quality are not just achieved via processes, but become defining, intrinsic personal and sociological values. Textbook definitions of quality, in their focus on productivity, distract us from the critical issues of motivation, aspiration, and socio-cultural context.

Construction management: quality and process

Writers on construction management place advancing quality management as a central concern. Harris and McCaffer (2013: p. 7) argue that quality management has *"become a strategic business function accounting for the raison d'etre of construction companies"*. They trace the evolution of quality management in construction over the past three to four decades from an inspection-based and intervallic approach, to the 'quality assurance' model still widely seen today (e.g. ISO 9000 standards family), and ultimately to growing adoption of Total Quality Management (TQM). The mantra of *"do it right and do it right the first time"* has been internalised in many areas of construction and reduction of rework and call-backs are held as important objectives.

Communication, learning and professionalisation

Fryer and Fryer (2004: p.142) report data collected by the BRE that place human factors as central to failures in design and construction phases. These included *"poor communication, inadequate information… inadequate checks and controls, lack of technical expertise and skills, [and] inadequate feedback…"*.

Learning within organisations remains a challenge in construction. This may be exacerbated by a history of low enrolment in higher education degrees (Dainty and Edwards 2003) and has implications for thought leadership. Approaches to capturing knowledge from projects have long been discussed (e.g. Latham 1994) yet remain underdeveloped (Tennant and Fernie 2013). Techniques such as post-project reviews (debriefing participants after project completion), intranets to capture and distribute knowledge, and 'centres of excellence' to centralise knowledge and expertise are not new (Winch 2002), but have remained underused (Carrillo, *et al*. 2013).

Hartenberger *et al*. (2013) argue that the construction industry might look to medicine for models of education, professional identity and ethos. The parallels between construction and medicine are noteworthy: they are both atomised professions consisting of networks of specialisation, and both have traditions of apprenticeship, and inter-and intra-disciplinary learning and interaction. The authors argue that professional practice in the built environment is impeded by barriers such as poor information capture, communication, rivalry and hierarchal thinking. Medicine offers models of problem-based learning, 'closed practice-research-education-training' loops, and unification toward a common ethos and identity (i.e. Hippocratic Oath).

AIMS AND OBJECTIVES

This research aims to improve understanding of the challenges the industry faces in delivering consistent build quality in light of dramatic changes in its landscape, and widespread concern that a legacy of inconsistent build quality and performance gaps is being perpetuated. The work analyses a small subset of the industry as it seeks to build new theory. Recognising limitations in generalizability inherent in its qualitative origins, the work is undertaken to complement other primary research and secondary analyses of SWI installation and performance, and study of the application of process and knowledge management practices in the SWI industry.

METHOD

This research used qualitative and ethnographic methods, following traditions of inductive theory-generating analysis. Since Glaser and Strauss introduced the concepts of constant comparative method and grounded theory (1967), discourse has muddled the bipolar distinctions between deductive theory-testing approaches and inductive approaches to analysis. Further arguments have debated the tenability of theory 'discovery', asserting that the research 'world' is fundamentally a socially constructed one (Orton 1997). This project recognises the complexity of 'knowing' and situating discovery, and is informed by numerous traditions including ethnography, inductive and interrogative approaches, and organisational research.

The research evolved in three phases which narrowed in focus from discovery to directed investigation of a single organisation. Discovery research included unstructured and semi-structured interviews (typically one hour) with 24 academic and professional experts to document prevailing perceptions and concerns about SWI installation practices and performance gaps. In the second phase, roughly 300 hours of non-participant observation and unstructured interviewing included an array of actors (installers, surveyors, researchers, energy company staff engaged with ECO, training colleges and trainers, site managers, principal contractor officers). In this phase, themes discovered in Phase 1 were explored in greater detail, and new themes were allowed to emerge. In the final phase of research, 18 weeks of non-participant and participant observation -- including several weeks working in the role of SWI installer – took place in a leading SWI installation company. Here, the majority of study focused on contract managers and site managers, but included installers, trainers, surveyors, senior management, business development, and a QA officer.

Professionals and institutions across central and southern England and southern Wales were included in the first two phases of research. The extended study made in the third phase of research was sited in a leading SWI installation company which works across England and Wales. The vast majority of observation was made in area-based retrofit projects through shadowing and conversing with participants. The inductive nature of the research demanded that a cross section of industry and SWI actors was captured and that sustained access was available in order to develop nuanced understandings. The methods employed were selected to enable the collection of 'rich' data and to develop an understanding of the complex actor-networks at play. Certain challenges were encountered; most noteworthy were the minimisation of researcher bias and 'observer effect' and creating and sustaining access at both individual and 'community' scales. Bias and observer effect are – to an extent – inherent issues in the research methods. Mitigation was sought through the employment of strategies such as coding, constant comparative method (triangulation), and 'theoretical saturation'.

Observation was limited to the number of actors and sites that could practically be included in the research, and it is recognised that the theories generated should be tested in future research. Research captured roughly 100 experts and professionals and 1,000 in-process or newly-completed retrofits. Observation was made in varying degrees of duration -- wherever possible, over hours or across days. Shorter interactions and observations (not included in the above numbers) contributed to 'saturation' in analysis but did not provide a substantive basis to the research.

RESULTS

Results are reported here by significant themes and topics emergent in data analysis.

Industry overview

The SWI 'industry' is more aptly described as an atomised system of actors working in diffuse subcontracted relationships. Contracts are led almost exclusively by SMEs which allocate works broadly to micro- and small-scale organisations. Specialist installers of SWI are very often 'upskilled' tradespeople with backgrounds in the 'biblical trades'. With recent growth in the industry, an emergent population of workers for whom SWI installation is their first profession can be found.

Installation quality

From initial stages of research, consistent anecdotal reports described a legacy of poor build quality in the SWI industry. Observation in subsequent stages suggested the persistence of this problem as quality defects (aesthetic and functional) in installation were observed repeatedly. Although this was not a quantitative study, it was clear that significant defects of both types were common (perhaps appearing in one of two retrofits observed), with more serious defects being observed in roughly 5-10% of retrofits and minor defects being nearly ubiquitous. Aesthetic defects were largely in either rendering or detailing. Examples of common functional defects included:

- Poor butting of insulation boards or inadequate fixing
- System boundaries not sealed adequately
- Emergency gas shut-offs or ventilation openings inadvertently blocked
- Weep holes or capillary grooves in windows and cills compromised
- Inappropriate insulation material or render specified for local climate
- Renders and adhesives applied or stored in unsuitable conditions
- Vapour control missing/ 'vapour permeability' not provided
- No insulation installed in floor-ceiling voids, floor or roof junctions

Policy and 'artificial pressures'

The primary business model of nearly all SWI principal contractors (as reported by participants) is to secure and deliver contracts with energy companies under government-led energy and emissions reduction programmes (e.g. ECO, CESP, Green Deal). The UK's largest energy companies are required to fund energy and carbon reduction projects. In these programmes, companies negotiate with contractors (or agents) who in turn deliver notional reductions in emissions through SWI retrofit.

What emerges is a 'low hanging fruit' scenario. Natural economic forces dictate that the easiest and cheapest reductions will be made from area-based projects of homogenous building stocks. This results in a 'gold rush' phenomenon: a scramble to secure funding and deliver as many retrofits as possible at the lowest possible price.

Meanwhile, policy instruments set de facto quality norms such as required guarantee periods or prescribed QA obligations. Rather than serving as minimum acceptable standards, these become normative influences. The 25-year guarantee period introduced by ECO (expanding the 10-year period in CESP) was seen to trigger a concentrated effort to improve build quality, but only to the 25-year threshold.

Training and certification

Formal structures for learning and certification serve 'first-tier' agents (e.g. installers) but no directly relevant structures serve management or 'second-tier' roles. PAS 2030 certification is an integral part of new government-led programmes and has triggered an increase in enrolment in programmes leading to NVQ 2. This is one of the few formal mechanisms of skill and knowledge assessment, though manufacturers widely offer abbreviated training and certification related to their proprietary systems.

Participant observation of training programmes found a heavy emphasis on 'site proficiency' (e.g. health and safety, rudimentary process skills, procedural knowledge). Little content highlighted the unintended consequences of improper installation, nor instilment of professional ethos or identity. Moreover, trainers frequently betrayed poor understanding of fundamental concepts.

Perhaps more troubling was opinion registered from several figures of authority that training colleges have a *"money first, quality not"* outlook. One NVQ instructor noted, *"these places are like [expletive] factories. It's like a conveyor belt. It's been quantity over quality. Because it's about money at the end of the day you know, isn't it. They just care about numbers. They just race them through here and as long as they make their money, well if they [installers] learn something on the way through that's great."*

'Short-termism' and workplace culture

"I honestly believe that in the coming years, companies are gonna be making a lot of money doing remedial works to the systems that have already been installed". This sentiment was relayed by a senior installer/NVQ instructor/assessor, and echoed that shared by several other actors. It conveys a dispiritedness with the work-world in which the installer produces and suggests an emotional distance from the 'companies' (capital holders) who stand to gain/endure in a system of poor production quality.

Professional pride was observed to vary widely, but generally was limited. Crews worked frenetically in response to 'pricework' (pay based on insulated wall area). This parallels principal contractors who are paid on a 'carbon tonne saved' basis. The role of 'EWIer' was spoken of by one particularly enthusiastic trainer, but this was a rare recorded instance of shared professional identity. Pride largely was observed in relation to ability to produce 'coverage' (i.e. earn money quickly), but seldom in relation to tacit knowledge, skill, or technical expertise. In contrast to Sennett's (2009) observation of *"obsessional energy"* in the manufacturer and sushi chef, little evidence was found of a culture that internalised quality as a personal or sociological value.

Construction management and quality assurance

Site managers, contract managers, directors, and quality control officers had most commonly 'moved up' from working as installers and had learned management 'on the job' with little or no formal training. Although their background positioned them to possess important tacit knowledge, they displayed little understanding of technical

knowledge or expertise in formal management practice. Some formalised elements of management practice were visible; for instance, risk and methods statements (RAMS) were widely used in order to comply with health and safety norms and regulations. CESP and ECO (among other programmes) require inspection and documentation and this clearly stimulated a degree of formal management practice. Equally important, the area-based scale at which organisations now work demands effective approaches (be they formal or informal) to process management.

Rudimentary management practices were observed as dominant, with broad reliance on informal techniques. Quality inspections in one company, for instance, were based on the use of a tick-box inspection using an inspect-and-display system akin to the proprietary Scafftag system used for scaffold safety inspection. The 'QA card' for each house was filled in during a sequence of post-task inspections by site management. It served a complex function – as much a signifier of control, or agent of power used to concretise management's authority, as a technically functional tool. Viewed another way, the card provided talking points, and so structured and enabled casual discussion between actors on site. As a primary tool of management, though, it was wholly unsophisticated and incapable of capturing the complexity of retrofitting.

Senior management in all but one principal contract organisation indicated that they rely heavily on 'walk-arounds' and site managers to 'catch' poor practice and determine retroactive solutions (rework). In Lavender's (1996) analysis, this represents the lowest form of management evolution. The system's limitations did not appear to be recognised by senior management; one officer discussing the inadvertent covering of an air vent for a gas fire remarked *"it's not a procedure problem, it's a person problem – somebody's not following it [best practice], you know"*.

Contractors, energy companies, manufacturers, policy instruments (e.g. ECO, CESP), and regulators rely on systems of third-party guarantors to insure against poor delivered quality. Distrust of this system was routine as many doubted that guarantors would in fact 'pay out' in the event of failures. In one installer's words, installers would ultimately be *"hung out to dry [for] anything and everything"*. This view was echoed by an NVQ assessor who told several installers, *"I don't care how good you are, you will miss something out – whether it's a bead or a fixing or a seal – and that's what they they're [manufacturer's warranty guarantor] looking for; it's a way out, to throw it back at you."* Rather than unifying multiple roles toward a pursuit of quality, this system appears to perpetuate a culture of transferred responsibility.

DISCUSSION

Unintended consequences

In principle, installation of SWI is a simple undertaking and installation procedure is dictated by manufacturer specifications for material selection, installation procedure and standardised detailing solutions. This systemised approach to 'design' is largely effective in securing build-quality. Crucially, however, failure to follow specification, or recognise instances when it was insufficient, appeared to occur regularly. Specifications are an important 'safety valve', but poor planning and oversight of their realisation propagates risks of underperformance and unintended consequences.

Understanding, expertise, motivation and technology

Levels of competency and technical knowledge in the industry were generally observed to be low. Formal training programmes have a crucial role to play here but require retooling to better distribute technical knowledge. Meanwhile, conveyance of

tacit knowledge appears limited in formalised structures and is impeded by 'clustered' knowledge flows in everyday work-life. Knowledge management strategies highlighted by Winch (2002) and Carrillo (2005) may offer useful lessons. Incorporating the 'knowledge integrator' concept (Janda and Killip 2013) and breaking down boundaries of traditional identities (Hughes and Hughes 2013) may also be important strategies for accumulating and dispersing new knowledge bases.

Installation quality is largely the result of innumerable small-scale decisions made during the process of deploying SWI. These decisions are formed largely in the context of the complex work-world (external forces) and its shaping of individual producers. Hence, quality is a 'human' problem with all of the complexity that this entails. It would be an incomplete analysis, however, to understand quality only in combinations of social or institutional analyses. Clearly, the agency and constraints of technology exert a normative and determinative force too; appropriateness of selection of materials, strategies of work, and systems of oversight seem to suffer accordingly.

Policy

Top-down mechanisms for incentivising retrofitting have clearly stimulated remarkable growth in SWI installation. Their disjoined nature, however, has inadvertently exacerbated difficulties in achieving consistently high levels of quality. Principal contractors cope with temporal pressure while striving to maximise productivity within funding windows; this 'gold rush' mentality trickles down to sub-contractors. Meanwhile the de facto standards and expectations imposed by these programmes (e.g. ECO's 25-year guarantee period) were generally observed in the field to have minimal real impact on quality or management practices.

Management

SWI retrofitting, like nearly all refurbishment work, is inherently an unpredictable endeavour. Systems of management must control as well as respond to this unpredictability. Compared to other sectors, new domestic construction exhibits less formal and often less sophisticated management practices. Perhaps it is unsurprising, then, that the domestic 'repair, maintenance, and improvement' sector – of which SWI retrofit is a part – exhibits wholly immature management practices (Killip 2011). Loosely formalised and primitive forms of management are clearly not passing the 'fit for purpose' test; indeed even more codified but traditional approaches to quality control –last at the vanguard of management practice several decades ago – are routinely failing the SWI industry as it strives to improve 'quality'.

'Quality' has been described as a multi-faceted concept. Effective quality management is built on better 'systems of work', but it also draws on complexities of identity constructs, organizational and personal communication, knowledge management, and shared aspirations and professional pride. Moreover, management must meet the challenge of facilitating exchange of explicit as well as tacit knowledge.

The industry must pursue procedural improvement while also seeking to inspire Sennett's concepts of motivation and pride. The industry is shaped by a variety of forces: its inherited legacy, dependence on instruments of government policy, reliance on outside (i.e. not SWI) educational entities, its supply chains, and internal structure are all significant. Meanwhile, Latham's critique remains deeply relevant. Wherever possible, the industry should be compelled toward progressive action and adoption of best (if not vanguard) construction management practice.

If it can curtail poor practice, the industry stands to make substantial gains by capitalising on the momentum of government support for SWI. This will be jeopardised by collective failure to advance practices. To date, advances in construction management practices have been imposed via policy instruments (e.g. ECO and Green Deal), and this may continue to be an effective mechanism for progressive reform. In addition to improving 'quality', management practices can also serve to forge common identity, pride and ethos, and to bolster knowledge exchange.

CONCLUSIONS

This paper has presented preliminary results and analysis from extensive qualitative research in the UK SWI retrofit industry. Findings corroborate anecdotal reports that the industry perpetuates a legacy of poor build quality and immature construction management. The research goes beyond this to develop new approaches to understanding drivers of and barriers to improvements in SWI practices.

Patterns of 'short-termism', financial pressure, policy impacts, limited technical understanding and immature construction management practices are identified as recurrent impediments to installation quality. In light of the industry's recent explosive growth and its legacy of poor installed quality, the research asks how these barriers might be overcome and how more robust management practices might be adopted for use in the retrofit context.

Analysis of the research is still at an early stage and will continue to evolve over the coming year. Certain limitations are inherent in the research design and these include the generalizability and the vulnerability to (or reliance on) subjective interpretation of data. In light of these limitations, further work on the topic might either enhance the work's generalizability or challenge its theoretical bases.

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