

QUALITY MANAGEMENT IN UK SOCIAL HOUSING PROJECTS: ADDRESSING THERMAL PERFORMANCE

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Construction defects in the domestic sector, especially those occurring in the building fabric, are acknowledged to contribute to the mismatch between the energy use as predicted at design stage and as measured in the building operation. Despite the number of quality management procedures put in place in social housing projects, defects affecting the thermal performance of dwellings are still a major issue to be managed. Within this context, this study investigates how Project Quality Plans related to thermal performance of dwellings are defined and implemented in the UK social housing projects. The analysis of evidence collected from five social housing case studies suggests that in the majority of the projects, the deployed quality management procedures focuses on visual quality issues, allowing defects with the potential to impair the thermal performance of the dwellings to remain uncorrected. Despite a range of quality control procedures administered by the projects' stakeholders, they did not systematically appraise such defects neither during preconstruction phase, nor during the construction stage. This study identifies the main challenges posed to the development and implementation of Project Quality Plans with focus on the thermal performance of dwellings. In addition, recommendations focused on offsetting the identified challenges are proposed as means to mitigate the quality issues affecting the thermal performance in social housing projects.

Keywords: quality management, defects, thermal performance, social housing

INTRODUCTION

In the UK, social housing associations (HA) are independent non-profit organisations who rely partially on government funding and partially on private finance to fund the construction of new dwellings (McManus *et al.*, 2010). HA play an important role in the UK housing sector, as well as being an essential part of the country's social security net, providing affordable letting to a substantial portion of the population.

In line with the objectives undertaken in the Climate Change Act 2008 (HMG, 2008), in the recent years the UK social housing sector has engaged in a large-scale effort to reduce carbon emissions, mitigate fuel poverty and increase the comfort level for their tenants (NEF, 2016). In fact, in 2016 the social housing sector presented higher average of SAP ratings (67), against the average of both private rented and owned occupied dwellings (61) (MHLG, 2018). However, recent studies on actual energy

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consumption indicate that the energy savings intended from the thermally efficient retrofits and new-built homes are falling short of their targets (NEF, 2016). This mismatch between the energy performance as predicted at design stage and as measured once the building is in operation is known as the buildings' energy performance gap (Zero Carbon Hub, 2014, de Wilde, 2014). Unless consistent measures are taken in the social housing sector aiming to help projects to achieve expected thermal performance levels (i.e. targeted fabric u-values and air tightness), the reductions of energy demand and CO₂ emissions aimed by the Climate Change Act 2008 (HMG, 2008) will not be met.

Among a wide number of contributing factors to the energy performance gap, poor quality management and the occurrence of defects in buildings' fabric have also been acknowledged (Gorse *et al.*, 2012, de Wilde, 2014). It is broadly claimed that the origins of these root causes are related to the "traditional construction model", encompassing poor teamwork across design and construction processes and inadequate technical literacy on thermal related quality issues (Tofield, 2012, Zero Carbon Hub, 2014).

As stated by researchers such as Hopkin *et al.*, (2016), HA are seeking ways to improve their Project Quality Plans (PQP) and to learn from recurring defects. However, they recognize that they are lacking a clear understanding of the best practices which would lead them to attaining the desired quality standards and thus achieving desired thermal performance targets (NEF, 2016). This paper aims, firstly, to identify the challenges faced in UK social housing projects in relation to the definition and implementation of PQP with a particular focus on thermal performance of dwellings; and secondly, to propose recommendations to overcome the identified challenges.

Globally, buildings are acknowledged to play a large role in the current energy use worldwide, being responsible for 40% of primary energy consumption and thus for 40% of the total amount of CO₂ emissions (IEA, 2016). In 2017, the domestic sector in the UK accounted for approximately 28% of final energy consumption (DBEIS, 2018a), 63% of this energy was used for space heating (DBEIS, 2018b). Therefore, to achieve the carbon emission targets it is pivotal to reduce the heating energy use in the sector by upgrading the thermal performance of the existing housing stock and building new energy-efficient dwellings.

In this regard, in 2008 the UK government committed to a legally binding target of reducing by 80% the 1990 carbon emissions levels by 2050 (HMG, 2008). This initiative was entailed by a number of mandatory and voluntary standards and codes for sustainable design and construction of buildings, aiming to increase the energy efficiency in the domestic sector. The Approved Document Part L1a (HMG, 2013) is part of UK Building Regulations and defines standards of energy use and carbon emissions, setting requirements of heat gains and losses in new dwellings.

The occurrence of quality defects in construction industry can potentially impact negatively in several dimensions of projects' performance, such as programme, budget, reputation, customers' satisfaction, health and safety, as well as the thermal performance of buildings (Alencastro *et al.*, 2018). Although there has been an ongoing effort to improve building quality through the implementation of quality programmes, the task of quality management in construction projects often proves itself to be challenging (Karim *et al.*, 2005). Construction projects are often one-offs, built in unique circumstances with transient organizations formed by multiples

stakeholders with diverse backgrounds and objectives (Briscoe *et al.*, 2004, Gorse *et al.*, 2012).

Historically, quality management in construction projects has adopted managerial practices developed in manufacturing industries translated into standardised Quality Management Systems (QMS), following the principles of quality management devised by authors such as Kanji and Wong (1998) and Deming (2000). However, due to the fragmented nature of construction sector, authors such as Karim *et al.*, (2005) and Jraisat *et al.*, (2016) have questioned the compatibility of QMS such as ISO 9001 (BSI, 2015) with the construction sector. The authors claim that these QMS does not present the desired flexibility to encompass the particularities and uniqueness of projects, resulting in unnecessary bureaucracy.

Karim *et al.*, (2005) and Harris *et al.*, (2013) suggest that the principles of quality management should be employed in frameworks that can be tailored for individual projects. PQP should be negotiated project by project, encompassing technical characteristics, as well as stakeholders' managerial background. Nevertheless, the successful implementation of PQP are dependent on two key aspects: the definition of specific quality requirements and assessment of necessary resources.

The definition of the quality objectives entails the recognition of the relevant functions and performance attributes of the resulting building that should be pursued by the PQP (Harris *et al.*, 2013). In that sense, the identification and understanding of the clients, occupants, statutory authorities and regulators' requirements are key to develop and implement quality plans which help to deliver the expected quality standards (Jraisat *et al.*, 2016). In addition, it is equally important that compliance procedures are aligned with the quality objectives, establishing unambiguously the evidence necessary for the compliance with quality standards (Karim *et al.*, 2005, Gorse *et al.*, 2012).

Quality resources assessment explores the identification and provision of essential resources to develop and implement PQP (Juran, 1993, Harris *et al.*, 2013). It is also necessary to establish the roles and responsibilities among the projects' participants in terms of who is responsible to undertake and exert the authority over each of the stages of the implementation of the quality program. In that sense, the capability of those involved, the financial resources and external support required must be assessed.

The existing knowledge establishes a sound theoretical basis for the development of quality management frameworks in construction projects, highlighting the importance of recognising quality objectives and making available the necessary resources for the implementation of PQP. However, there is a shortage of studies and sufficient information to provide a full understanding on the fact that despite the number of quality assurance procedures put in place in UK HA's projects, defects affecting the thermal performance of dwellings are still a widespread occurrence.

METHODOLOGY

This study adopts a qualitative approach by means of an explanatory design where empirical data was collected and analysed to explore in detail the established phenomena (Bryman, 2012). For this purpose, five case studies of new-built UK social housing projects were selected to investigate the challenges to the development and implementation of PQP with focus on thermal performance.

The methods of data collection and analysis were devised based on Grounded Theory (Corbin and Strauss, 2008). In order to organise the data collection and analysis

which enabled constant comparison across case studies and existing knowledge, a conceptual framework was developed (Bryman, 2012) containing two of the main areas of PQP: (1) Definition of quality requirements and (2) Quality resources assessment.

Empirical investigations must rely on multiple sources of data in order to avoid biased conclusions (Bryman, 2012). In that sense, the main data collection procedure used was semi-structured interviews with key stakeholders: housing associations (i.e. project managers) and contractors (i.e. project and site managers). In total fifteen interviews, three per project, were undertaken. Additional data was collected by means of: (i) quality management documentation (quality policy and plan, checklists, etc.); (ii) observations during projects' management team meetings and construction site visits focusing on the implementations of PQP; and (iii) construction defects identification surveys undertaken by the researcher during the construction process. These additional sources of information were used to confirm or to challenge the findings emerging from the semi-structured interviews. In total, five case studies were selected (Table 1) and their original denominations were substituted by Case study 1 to 5 in order to ensure confidentiality.

Table 1: Summary of the case studies included in this research

	Case study 1	Case study 2	Case study 3	Case study 4	Case study 5
Location	Cornwall	Cornwall	Devon	Devon	Wiltshire
Number of units	28	39	67	72	40 (121) *
Contract value (£)	3,100,000	4,000,000	8,300,000	10,000,00	5,000,000
Energy performance target	Part L1a	Part L1a	Part L1a	Passivhaus	Part L1a

* This case study is a developer led project of 121 housing units where 40 dwellings were acquired by the HA.

The data was collected from December 2015 to February 2018, and key findings were grouped into the two main areas to PQP. In order to assess the validity of the results, three focus groups were undertaken with the participation of experienced professionals of similar projects, such as project managers, site managers, consultants, building surveyors, building control approved inspectors and academics. The main goal was to verify if the challenges identified in the case studies were also experienced by the focus groups' participants, and therefore the study's results could be generalised to other similar social housing projects.

RESULTS

In terms of the general quality approach adopted by the investigated HA, it was observed that HA have a genuine interest in improving the levels of energy efficiency and thus an intent of reducing fuel poverty and energy bills of tenants, as well as the environmental impact such as carbon emissions. However, as explained by the project manager of the housing association in case study 1, due to financial constraints led by cuts in social renting values and limited funding, the adoption of more ambitious thermal performance targets has been suspended since 2015. As a consequence, four out of five case studies only adopted the compliance to Part L1a of Building Regulations as the ultimate quality goal in terms of thermal performance. The exception was case study 4 where the adopted thermal performance targets were the Passivhaus standards.

The analysis of collected data made evident that in all case studies a clear definition of the quality objectives was provided by the housing association or developer in the

early stages of the project, via "employer's requirements" (e.g. project toolkit and technical specification). These objectives were part of tendering documentations and contractual requirements. It is important to state that specifically in Case study 5, the HA's business model was predominately focused on buying housing units from the open market developers instead of commissioning the construction of their new assets. Consequently, little input was provided in terms of the definition of the quality requirements. However, the HA would only acquire new assets providing they met the Building Regulations requirements as a minimal standard.

In Case studies 1, 2, 3 and 5 the challenge posed to the achievement of the quality objectives regarded to thermal performance was that the defined compliance process did not encompass the quality assurance procedures undertaken by neither the housing associations nor the contractors. The ultimate quality compliance requirement was to obtain statutory approval, where the quality control and compliance confirmation was assigned to a third party, i.e., building control bodies (BCB). Thus, the establishment of this compliance process defined the approach of the PQP developed and implemented by HA and contractors, especially in the allocation of resources and the emphasis applied on the quality control procedures.

In terms of formal procedures, in most case studies quality control procedures focusing on defects with potential to impact on thermal performance of the buildings were defined and implemented by BCB. Although the quality control procedures applied by BCB used a standard approach, only five key stages of the construction process were established for quality inspections (i.e. foundations, drainage, superstructure, pre-plaster and pre-handover). It is also important to acknowledge that from the five inspections stages, two of them (i.e. drainage and pre-handover) offered very few, if any, opportunities to identify quality issues affecting the thermal performance of the dwellings through visual identification. Moreover, BCB inspectors also had an extensive amount of quality attributes to check related to other parts of Building Regulations. Moreover, the process of appraising quality relied mostly on their experience and awareness rather than the use of a structured quality checklist as guidance.

Summarising, the majority of the case study results suggests that quality objectives related to the thermal performance were defined following the specifications of the UK Building Regulations as the minimum standard. Therefore, the ultimate quality control and compliance procedures concerned to the thermal performance were assigned to building control parties. Consequently, no formal quality compliance method was defined and implemented by the HA and contractors. Because the ultimate compliance procedure for the quality objectives related to thermal performance were assigned to the BCB, the HA had no control over the process of assessing and reporting quality compliance. Thus, the definition of the necessary evidence for quality compliance and resources applied in the process of quality control were neither tailored to the project, nor aligned to the housing associations' long-term objectives.

The findings suggested that multiple layers of quality control procedures were resourced, and roles and responsibilities were assigned in order to ensure the achievement of the desired quality requirements. However, as mentioned the ultimate authority in terms of awarding the final quality compliance concerning to the quality objectives related to thermal performance was given to BCB, in exception of Case study 4. Therefore, in the majority of the case studies an imbalance between quality

control efforts put in place in different stages of the construction process was observed. Quality appraisal procedures put in place by HA and contractors were intensified in the practical completion stage of the construction process. For instance, in cases studies 1, 2, 3, and 5, contractors' interviewees explained that during certain stages of the construction process the effectiveness of the quality control procedures were compromised due to the lack of appropriate allocated time and human resources. In Case study 4 where Passivhaus accreditation was required, a dedicated quality officer was assigned in addition to the usual managerial team to monitor specific building elements where defects were likely to occur.

In respect to the quality control required to achieve UK Building Regulations approvals, approved inspectors were appointed by the contractors/developers to inspect the sites in all case studies. The findings revealed an issue related to resources constraints within BCB. The number of approved inspectors were mentioned to be insufficient and often they were not available to undertake inspections whenever project's dwellings reached a defined key stage for quality check. As a result, a number of housing units were not inspected in certain key stages of construction due to the fact that subcontractors did not want to be penalised for programme delays in case of having to wait for the availability of the BCB inspector. The lack of resources and time constraints also impacted on the regime of inspection. The available time slot for the site inspection did not always allowed the appraisal of all the dwellings expected for each visit, leaving some dwellings unassessed. Anecdotally, a BCB's surveyor, participant of one the focus groups, confirmed the scarcity of resources, stating that quality control regime of assessing all housing units of the surveyed project is not being followed as it should. The surveyor revealed that building control activities are being undertaken through sampling due to lack of human resources.

In terms of resources deployed for upskilling and to increase awareness of quality requirements and the impact of defects on the thermal performance of the dwellings, the results revealed that similar approaches were adopted in the case studies, in exception of case study 4. As relevant quality objectives were embedded in contractual and design documentation, the HA did not formally require that additional activities were undertaken with the workforce on-site. Thus, in the majority of the case studies, apart from the initial site inductions, no other initiatives could be identified in terms of upskilling or increasing awareness of the site operatives. Moreover, it was apparent in case studies 1, 2 and 5 that the only formal induction provided to the operatives was mostly regarded to Health and Safety issues. In fact, the site management held meetings with the subcontractors' supervisors on a weekly basis, however the main focus was the planning and the achievement of construction programme milestones. In Case study 4, there was a concern about the level of technical knowledge across the supply chain and site managerial team jeopardising the achievement of the thermal performance targets. It thus led the contractor to deploy training courses ran by the Passivhaus consultant. The site managerial team and subcontractors' supervisors received technical training and were made aware of the potential quality issues which could undermine the ultimate thermal performance of the dwellings.

In conclusion, in the majority of the case studies the ultimate quality compliance related to the thermal performance of dwellings was assigned to BCB. As a consequence, housing associations and contractors concentrated their efforts and resources to undertake quality control procedures mostly on the final stages of the construction process. At that phase, defects affecting the thermal performance of the

dwellings were enclosed within the building fabric and could not be detected through the deployed procedures. It was identified in case studies 1, 2, 3 and 5 that the deployed resources for the quality control procedures compromised the administration of the PQP, undermining the ability of the defined procedures to detect defects and thus, impacting on the achievement of the quality objectives. In the majority of the case studies it was observed that the only formal activity with the purpose of increasing workforce's awareness were health and safety inductions. Training sessions and upskilling activities aiming to develop technical knowledge and capabilities, as well as increasing the levels of awareness toward the projects' quality objectives were only observed in case study 4.

DISCUSSIONS

As evidenced by the results, the main challenge posed to the achievement of quality objectives related to the thermal performance of the investigated projects is the fact that the ultimate quality compliance was assigned to third parties, i.e., BCB. This approach reduced the drive and motivation of PQP implemented by HA and contractors, undermining their ability to address quality defects impacting on thermal performance of the dwellings. The quality control procedures devised and implemented by BCB presented inadequate structure in terms of providing guidance for the identification of thermal building defects. Moreover, resources put in place were deemed insufficient, impacting negatively on the implementation of the devised quality control procedures.

The inefficacy of BCB on assessing the achievement of quality objectives, although granting statutory approval, is something of great concern also manifested in other studies. For instance, the National Energy Foundation's report on energy efficiency of UK social housing projects (NEF, 2016) shows that 33% of the 48 projects investigated presented external walls' u-values failing to meet the Building Regulations' threshold, even though all the projects were awarded with statutory approval. Moreover, reviewing the tragedy of the Grenfell Tower fire (BBC, 2018), the Hackitt report indicates that the UK's regulatory system suffers from an inadequate oversight and enforcement tools (Hackitt, 2018). Hackitt (2018) highlights the weaknesses of the current structure of BCB in terms of scarce resources and the inspectors' inability to undertake quality control activities. Moreover, the report mentions the conflict of interest of BCB between using the enforcement methods and fear of losing long-term businesses. This statement was also manifested by the head of development of the housing association in one the case studies, denoting the lack of credibility of the current arrangement.

It is equally important to acknowledge that construction projects are mostly one-offs, built by a temporary group of participants, using different construction methods (Briscoe *et al.*, 2004, Gorse *et al.*, 2012). In that sense, HA must be able to adjust quality objectives and compliance procedures to the particularities of projects in regard to their construction methodology and sequencing. In addition, the use of PQP is more suited to accommodate the particularities of each project, rather than the inflexible standardised QMS. Karim *et al.*, (2005) also stated that the success factor to the development of quality assurance procedures are down to the project level and not linked to standardised QMS.

The findings also suggest that contractors and subcontractors should be made fully aware by the HA of what is expected from them in terms of the quality requirements, but also how and when evidence of quality compliance should be reported. The

compliance procedure must be designed to determine that the contractor is responsible for providing evidence that the workmanship is undertaken at the desired level, where specific building elements are free from the defects highlighted at the stage of risk assessment. It is fundamental that these requirements are embedded in contractual documentation where the contractor is legally bound to deliver the expected quality standards. The compliance procedure should ensure that building elements are compliant with the technical drawings and the specifications of the project (Gorse *et al.*, 2012).

In this respect, HA have a vested interest in the uptake of PQP that enable the delivery of thermal performance translated into quality objectives. HA are the institutions that are responsible for commissioning and maintaining social housing and most importantly promoting the wellbeing of social tenants through the delivery of energy efficient dwellings. Therefore, it is reasonable that HA should participate actively not only on the establishment of quality objectives but also the definition of quality compliance procedures to be assigned to contractors, even when only statutory approval is required. Researchers such as Briscoe *et al.*, (2004) and Karim *et al.*, (2005) claim that active client participation in the process of establishing quality objectives and compliance is vital to drive the process of quality assurance, as well as to increase contractors' levels of awareness towards the risks involved to achieve the desired standards of quality.

As stated by researchers such as Feigenbaum (1991) and Josephson *et al.*, (2002), the resources applied in quality management of construction projects are usually concentrated in three main areas: prevention, appraisal and correction. The findings demonstrated that most of the resources put in place in the investigated case studies were concentrated in the appraisal and correction activities. Very little was invested in prevention, through upskilling activities focusing on technical capability and awareness. The results presented a similar trend to what is experienced in the construction industry, where very little resources are allocated on the prevention of quality issues (Josephson *et al.*, 2002, Tofield, 2012). The lack of focus and awareness towards quality issues, in this study impacting on the dwellings' thermal performance, converge with studies of Brooks and Spillane (2016) and Atkinson (2002). In fact, the lack of awareness of the quality objectives not only compromises the delivery of the expected standard of quality but also undermines the workforce's motivation and pride.

For the achievement of quality objectives focusing on increasing living standards in the UK social housing through the delivery of energy efficient dwellings, an important shift in quality management approach is required. It is pivotal that PQP provide more focus towards prevention, instead of correction. Channelling resources to prevention activities, such as upskilling and increase of awareness, enables the empowerment of the workforce, promoting motivation and pride in delivering quality first time, thus reducing correction costs. In addition, this approach promotes collaboration between the many stakeholders where quality goals are shared and are well known, shifting construction culture to a no-blame philosophy.

CONCLUSION

This study's main contributions to knowledge is the recognition that the sole adoption of statutory approval as the ultimate quality compliance related to the thermal performance objectives is not sufficient to achieve the set quality goals. Firstly, this approach reduced the drive and motivation of PQP undertaken by housing

associations and contractors. Secondly, the quality control procedures put in place by BCB proved inefficient. The findings demonstrate that the PQP were devised and resourced mainly to mitigate visible quality defects which were likely to be identified by tenants and thus become complaints to be dealt with. In most of the case studies, resources for quality appraisal procedures were concentrated in the final stages of the construction process, where defects affecting the thermal performance were already enclosed within the building fabric, remaining undetected and uncorrected. In order to promote the achievement of quality objectives aiming to improve energy efficiency, social tenants' living standards as well as the decrease of carbon emissions a shift in the quality management approach is required. It is recommended that change of culture must be achieved that promotes collaboration and participation, encompassing a clear definition of quality compliance and empowering the workforce to deliver the expected quality standards. Quality management practices related to prevention, i.e., upskilling and increase of awareness, should be prevalent over the correction of defects, thus reducing the cost of rework and promoting the achievement of quality goals.

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