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## Delivering energy-efficient social housing: implications of the procurement process

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### Abstract

The construction industry is often considered to perform poorly in terms of the quality of the products delivered when compared to other industries. However, developing and implementing quality management systems in construction is particularly difficult because of a lack of standardization, the intensive use of manual labour and the many parties involved. This paper explores the challenges faced by social housing providers in the UK when implementing quality assurance procedures in their effort to provide their tenants with energy-efficient homes. In particular, it focuses on the quality assurance procedures defined in the early stages of a project, at the procurement phase, and their impact during the construction process and on the ultimate building energy efficiency. Based on data collected from the project team and project documentation, a comparative analysis of the procurement process of two social housing developments in the UK is presented. The results of the study show that despite the two case studies pertaining to the same housing association, they followed different quality management approaches to deliver energy efficient dwellings. The most significant discrepancies were found with regards to the definition of energy performance targets, detailed quality assurance procedures and milestones for testing performance. The contribution of this paper is to create awareness of the importance of defining Quality Assurance Programs with a focus on energy performance from the early stages of a project.

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*Keywords:* Building energy performance, construction industry, defects, procurement, quality management, social housing.

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### 1. Introduction

In the current use of energy worldwide, buildings are considered to consume 40% of the primary energy and thus being responsible for 40% of the total amount of carbon emissions [1]. To address the issue, the UK government has committed to cut carbon emissions by 80% of 1990 levels by 2050 [2].

The UK domestic sector in 2014 accounted for approximately 26.5% of final energy use [3], 66% of this energy was consumed for space heating [4]. Consequently, to meet the carbon emission aims it is crucial to reduce the demand for heating energy in the sector by enhancing the thermal performance of the existing housing stock and building new energy-efficient homes. Aligned with the objectives established in the Climate Change Act 2008 [2], in the recent years the UK social housing sector has implemented numerous measures in order to mitigate fuel poverty and reduce carbon emissions in the operation of their assets [5].

Despite the amount of effort invested in this large scale endeavour, recent studies suggest that the energy savings envisioned by the energy efficient refurbishments and new-built homes are not matching their original targets. There is a common acknowledgement among social housing providers that the best practices which would lead them to achieving the energy performance targets are still to be set [5, 6]. Among various contributing aspects to the energy performance gap, poor quality management and the occurrence of defects have been recognized as important reasons to unexpected air permeability and thermal bridging, and thus leading to unpredicted heat loss [7]. According to Zero Carbon Hub [8], various quality assurance procedures have been deployed in the construction industry over the last decade; nonetheless other issues are considered prior to energy efficiency. In this regard, there is a need for an increased focus on quality towards energy performance of buildings which should be embedded in the early stages of projects and defined at the *Initiation* phase of the procurement process [9].

For many decades, procurement had the perception of being a bureaucratic function within an organization, merely a transaction method between the supply chain and the demand [10]. Recently, procurement has evolved into a strategic tool for achieving best value for owners by integrating social, economic, and environmental objectives [11]. As each construction project passes through a procurement phase, a significant potential exists in procurement to improve the project quality management. However, the full potential of procurement is not undertaken by the construction industry [11].

This paper intends to investigate (1) how the social housing providers define and incorporate quality management systems in the procurement stage of their new-built and retrofit projects, and (2) identify areas of improvement in these practices towards achieving higher building energy efficiency. It particularly focuses on how social housing providers address building energy efficiency in the initial conceptualization of the projects and the definition of the procurement process.

## 2. Procurement

It is a generally accepted concept in the construction industry that a project to be considered successful should be completed as scheduled, within budget and quality standards and fairly meeting the client's aspirations [12]. Undeniably, the achievement of these criteria has been associated to the appropriate selection and implementation of the procurement method according to the project's characteristic and complexity [13, 14].

The procurement method is a deliberate strategy which is designed to identify the best way of achieving the objectives of a project. It is an organizational system that defines the relationships of the various participants of the project, where responsibilities and authorities are assigned [14]. It also plays an important role in coordinating and linking the different parties of the building team throughout the building process, both functionally, defining roles and authority; and contractually establishing responsibilities and liability caps [10, 12].

Construction procurement can be analyzed under three perspectives: as processes, methods, and procedures [9, 15]. The process perspective explores the activities related to procurement, which spans from identification of project requirements to the project completion. The methods perspective analyzes the organization and rules for obtaining a constructed facility. The procedures perspective focuses in the means of obtaining bids and selecting contractors and suppliers.

### 2.1. Procurement processes

The procurement process encompasses the activities throughout the project, starting by establishing the client's aspirations and the business case and ending with checking the compliance of the previous requirements. According to BS 8534:2011 [9] which deals with the construction policies, strategies and procedures, the procurement process

can be divided in four main parts: *Initiation*, *Procurement strategy*, *Procurement tactics* and *Managing performance and delivery*.

The *Initiation* phase is where the business case is developed, identifying the project objectives, aspirations and needs. It also outlines the overall roles, responsibilities and accountabilities as well as carrying out a value management study [14, 16]

The next stage, *Procurement strategy*, is an extensive and crucial part where the initial conceptualization of the project is translated into objective information through the client brief. In this stage the procurement methods will be assessed and the chosen procurement strategy will be planned. The next steps in this phase are to define the work packages, the tender documentation containing the fundamental information for the bidding process and the selection criteria [9, 14].

*Procurement tactics* is the following step where the supporting activities will be defined in order to monitor and make accountable the project performances such as budget, programme and quality related issues (also expressed as Key Performance Indicators) [9]. The market will be contacted in order to set in motion the pre-selection process, depending on the procurement policies adopted. Later in this stage the tendering process will take place and the contract will be awarded according to the selection criteria and policies. In that phase the forms of contract will be defined and signed off between the owner and contractor/subcontractors/suppliers, encompassing not only budgetary and programme aspects but the project liability caps, as well as rules and responsibilities in process of achieving the expected outcomes [17].

The final part, *Managing performance and delivery*, is a systemic approach which aims to link the project goals developed in the first two stages and committed in the previous phase to the specific project's outcomes in the design, construction and operation phases. The approach should provide feedback in regard to the project performances based on facts and data, allowing the project managers to redirect the process whenever a mismatch of the preset targets is perceived or to remediate in the case of a late realization [9].

## 2.2. Procurement methods

The purpose of the procurement methods is to determine the division of labour between the parties, set the contractual relations and the rules of the design, construction and operation processes. The procurement aims to establish the price formation method, the project delivery method and the contract conditions. In that sense, the decision making process about the procurement method should only occur after the definition of the project objectives [18].

According to RIBA *member's online survey* in 2012 [19] undertaken with architectural practices across the UK, the most frequent procurement methods used are: *Traditional fixed price* (86%), *Single-stage design and build* (41%), *two-stage design and build* (39%), *management contract* (18%) and *Private Finance Initiative* (10%).

The *Traditional fixed price* (lump-sum contracting) is a single-stage method where the design and the construction activities are provided separately [14]. The process starts with the client/owner commissioning a consultant team, which can be either an in-home team or an external team, to produce a fully designed project. Then, a contractor is appointed through a tender process under a lump-sum construction contract which can include penalties for late completion or mismatch of quality related issues. This procurement route is very likely to lead to disputes and litigations over the contract variations or extras claims for the awarded contractor has no responsibility in the design stage. Moreover, it limits valuable construction management and buildability detailing because of the separation of the design team and the contractor [14, 16].

In the *Design and build* method the client manages the project with a single point of contact. The awarded contractor is responsible for both design and construction. This method starts with the client commissioning a design team to develop the project concepts and requirements by which the proposals are called in the tendering process [20]. Two-stage tendering is the method usually applied in this procurement route. It allows the early appointment of a contractor, prior to the completion of all the information required to enable them to offer a fixed price. In the first stage, a limited contract is appointed, allowing the contractor to engage in the project early stages. In that stage the consultant team hired by the client to support the preliminary activities can be novated to the contractor for the following stages. In the second stage, when more detail is available, a fixed price is negotiated for the rest of the

contract. This route of procurement supports innovative and cost effective solutions, combining design and construction expertise. However, it is likely that costs present inflation due to the bidding is being done with minimal design and site information, especially in single-stage tendering [10].

*Management contracting* is a procurement method in which the construction activities are undertaken by a number of different contractors who are hired by a management contractor [10]. The management contractor is generally appointed by the client early in the design process so that their experience can be used to improve the cost and buildability of the project, as well as to advise on the definition of the working packages and the risks of interfaces. It also enables some work contracts to be tendered earlier than others, and sometimes, even before the design is fully developed. This can shorten the time taken to complete the project; nevertheless, it means that there will be price uncertainty until the design is complete [21].

*Private Finance Initiative* is suited for large-scale projects like infrastructure, projects, hospitals and schools with budgets exceeding £20 million [16]. In this method a single integrated supply team is appointed by the public sector to design and build a development and then to operate it for a period of time [16].

### 2.3. Procurement policies and procedures

The procurement policies and procedures is defined by the values and aspirations of the client organization, and thus determine the selection process (tender) of the contractor/subcontractors which are expected to support the preferred procurement method [15]. According to Touran et al. [22] the procurement policies and procedures can be grouped into three selection criteria: *low bid procurement*; *qualification-based procurement*; and *value-based procurement*.

The *low bid procurement* (competitive bidding) is claimed to be a standard practice in the UK and the main cause of significant issues in the current procurement issues [10, 23]. This practice can lead contractors to reduce the allotted resources towards safety and quality assurance procedures or to contract less experienced and skilled subcontractors in order to maintain a healthy profit margin to the contract [23].

Some clients, however, are already realizing the benefits from implementing *qualification-based procurement* and *value-based procurement*, or even the combination of the two methods [23]. In the *qualification-based procurement* the selection criteria is based on the levels of the experience and ability of the bidders to fulfil successfully the required objectives of the project [9]. In a similar approach, *value-based procurement* seeks to obtain the best value for money, achieving the best combination of entire lifecycle cost and quality to meet the client's expectations [9].

## 3. Methodology.

The study's results were obtained from two case studies of a social housing association based in Devon, UK. The methodology sought to allow the researchers to explore in a holistic way how energy efficiency issues are raised among other objectives in the inception of the case studies and how these issues are addressed in the procurement stage. In order to avoid bias, empirical investigations rely on multiple sources of evidence [24]. Thus, this study reviews data collected from documents (minutes, contracts, tendering packages, quality programmes, etc.), technical information (plans, detail books, etc.), interviews with the project stakeholders (client, project manager, contractor, architect and consultant) and observations during the management and design meetings. Hence, this paper presents the initial findings of the early stages of the projects until the procurement phase.

Data is organized following the framework for procurement established by BS 8534:2011 [9] and BS ISO 10845-1:2010 [15]. The analysis of data and the subsequent conclusions are drawn by scrutinizing the case studies' findings under the following aspects: (i) procurement processes; (ii) procurement methods; and (iii) procurement policies and procedures.

## 4. Case studies

Case Study 1 comprises 72 new affordable homes design to Passivhaus standard [25]. The procurement route is

a two-stage Design and Build method with a combination of *qualification-based* and *value-based* tender criteria. The client appointed an external project manager to support the stages prior to procurement as well as to work as a facilitator for the whole process. The design team and Passivhaus consultant were novated to the contractor after the procurement stage.

Case Study 2 involves the refurbishment of 38 housing units grouped in 4 building blocks. This project is part of a 20 year retrofit scheme, funded entirely by the social housing provider. This programme follows a retrofit scheme which encompassed 4,009 units. It is expected that the external wall insulation installations will increase the current SAP ratings [26] of the retrofit dwellings from 71.6 to 81. A traditional procurement method is used for this project and the contractor was selected using the qualification-based criteria. For the design process, an internal team of the housing association was selected, based on the accumulated experience from previous retrofit works. The role of the project manager was undertaken by the company's asset manager.

## 5. Results

**Case Study 1:** At the initial stage of the project, the housing association's stakeholders decided to design the new homes to Passivhaus standard. An experienced Passivhaus consultant was commissioned early in the process to collaborate with the appointed design team and the external project manager.

The procurement method chosen was design and build. As the awarded tenderer would be legally bound to deliver the Passivhaus requirements, it was found important to commit the contractor to the initial stages of the project, taking responsibility for the design process. However, the design team and the specialist consultant were novated to the contractor in the following stages just after the tendering process.

The tendering was a two-stage process. Among the general project characteristics and objectives, the bidding information pack included: a clear set up of performance requirements (e.g. heating demand and airtightness); the description of the Passivhaus accreditation process; the performance tests to undertake during the construction process (e.g. airtightness tests); and a list of minimum performance specifications for products and equipment in order to comply with the Passivhaus standards. The pre-selected tenderers were asked to submit their tender comprising their price and programme for delivering the project along with proposals for how to fulfil the project's objectives. These proposals should also encompass the intended strategies to achieve the Passivhaus accreditation, to accomplish the design requirements, to manage the subcontractors and assess their performance and skills, and assure quality and rectify eventual defects.

**Case Study 2:** At the project's initial stage, the housing association asset management team declared their performance aims (i.e. increase the current SAP ratings from 71.6 to 81). Even though the housing association aimed for such a specific goal, there was no evidence in the project documentation of specific performance targets (e.g. u-values and air permeability) that the refurbishment scheme was expecting to meet. Additionally, the project documentation also lacked of the condition surveys of the building blocks to be retrofitted. A list of practical recommendations was developed by the asset management team based on the previous similar retrofit schemes, such as the retrofit works of the ECO schemes. This recommendation list became the basis for the definition of the technical requirements for both the tendering information packages and design stage.

The procurement approach chosen for the retrofit scheme was the traditional route, where both the design and the project management team pertained to the housing association staff and a main contractor is responsible for the construction phase only. The traditional route allowed carrying out the procurement and design outline stages in parallel. However, it limited the amount of involvement of the future contractor in the design process.

The tendering information packages, i.e. the invitation to tender documents and contracts, included a pre-defined technical solution for the external wall insulation. The asset management team defined the retrofit solution and its technical characteristics (mostly addressing to thermal bridging which could compromise the thermal performance of the buildings) based on previous experiences, where this technology had been deployed in previous works with apparent success and cost effectiveness.

In regard to the quality assurance plan, the housing association administered the set of procedures which are standard to similar projects they are undertaking. The tendering selection criteria was a *qualification-based* one and specified that the tenderers must maintain a recognized "quality assurance system" such as ISO 9001 certification. Apart from that, the housing association did not require performance tests or specific checking points to be

undertaken during the construction phase, as no performance targets were defined in the early stages of the process. In fact, the housing association's standard quality plan is focused on preventing visual defects which are likely to raise occupants' complaints but do not specifically concentrate attention in quality defects related to thermal issues. The main contractor is required to provide the housing association's representatives with quality reports once the work for one housing unit is deemed completed. In addition, the contractor must submit all the material invoices to the project manager as a way to prove that the products deployed comply with the design specifications.

## 6. Discussion

Since the first stage of the procurement process (*Initiation*) in Case Study 1 the client and its representatives were very clear about the expected outcomes of the project, as recommended by OGC [16]. In regard to the energy performance ambitions it was decided to commit to Passivhaus standard. In that sense, the Passivhaus framework provided a setup of energy performance targets and requisites which were necessary to support the decision process in selecting the appropriate *Procurement strategy*. In the Case Study 2, although the overall project goals were established following the apparent successful previous refurbishment works, in terms of the energy efficiency aspirations there were no objective and measurable targets to be pursued in the following stages of the procurement process.

In the *Procurement strategy* stage, in Case Study 1 the decision to comply with Passivhaus standards made the housing association stakeholders recognize that the in-home project team were not properly equipped with sufficient knowledge and experience to carry on neither with the procurement process, nor with the overall project management. Hence, a multidisciplinary team was commissioned to provide support to objectively define and produce the working packages, tender documentations and measurable energy performance outputs, especially regarded to energy efficiency attributes [14]. In respect to the procurement method, *Design and Build* was considered the best choice because this route allowed the contractor to join in the project on time to collaborate from the beginning of the design stage, committing the design development and construction delivery into a single point of contact towards the client management [20]. In Case Study 2, as the in-home project team had a strong background of housing maintenance and refurbishment accumulated in previous works, the option of using the *traditional fixed price* procurement seemed to be a natural choice. This procurement approach was meant to re-enforce the deployment of standardized technical solution and procedures, nevertheless it did not take into account the valuable contributions of the awarded contractor in the initial stages of the process. According to Miller et al. [27], in the construction industry, owners and project managers opt for procurement routes that had been successful in previous occasions. As a result, opportunities to increase the chances of a successful outcome are missed.

Regarding the last two parts of the procurement process (*Procurement tactics* and *Managing performance and delivery*), the tendering and contractual documentation analyzed in Case Study 1 provided robust evidence that the projects goals were translated into objective and measurable indicators, as suggested by BSI [9]. As per the energy performance targets, the documentation included a clear setup of building fabric properties such as air permeability and u-values, for instance, and specific methodologies and milestones for testing and reporting performance, all of these supported by the Passivhaus framework. The awarded contractor should be legally bound by contract to develop a bespoke quality plan in order to deliver the expected outcomes. In Case Study 2, although the tendering documentation and contractual requirements set up responsibilities and procedures regarded to a standard quality plan provided by the housing association, there is no evidence for the existence of checking points or performance tests related to the energy efficiency of the buildings. The standard quality plan is regarded to quality issues which are likely to raise complaints from the residents and is designed to identify visual defects after the completion of the external wall insulation works, addressing no formal procedures to assess quality issues related energy efficiency.

## 7. Conclusion

The research presented in this paper set out to investigate how social housing providers define and develop quality management systems and how energy efficiency of buildings is addressed. The results show that the managerial team of both cases acknowledged the role of quality management in achieving predefined project goals.

However, the case studies followed different approaches in how they set energy performance targets and how these targets are translated into objective procedures throughout the procurement process. While in Case Study 1 the energy efficiency aspirations could be identified in the early stages of procurement process and paved the development of a bespoke quality assurance procedures; in Case Study 2 the procurement process was fragmented, not allowing the definition of measurable energy efficiency targets and adequate quality assurance procedures.

The results suggest that in order to develop quality assurance plans which encompass energy efficiency in social housing it is vital to include energy performance targets as a fundamental objective to be pursued from the early stages of projects. In that sense, social housing providers must rely on a collaborative method of procurement which ensures that the project team has enough knowledge and literacy in terms energy efficiency so specific objectives can be defined and supported throughout the whole procurement process.

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