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Case Report

A Case Study of a Negotiated Tender within a Small-to-Medium Construction Contractor: Modelling Project Cost Variance

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Abstract: This research explores the failure of competitively tendered projects in the UK construction industry to procure the most suited contractor(s) to conduct the works. Such work may have equal relevance for other developed nations globally. This research seeks to teach clients and their representatives that "lowest price" does not mean "best value", by presenting a case study of a successfully negotiated tender undertaken by a small-to-medium enterprise (SME) contractor; SME studies are relatively scant in academic literature. By applying the "lessons learnt" principle, this study seeks to improve future practice through the development of a novel alternative procurement option (i.e., negotiation). A mixed philosophical stance combining interpretivism and pragmatism was used—interpretivism to critically review literature in order to form the basis of inductive research to discuss negotiation as a viable procurement route, and pragmatism to analyse perceptions of tendering and procurement. The methods used follow a three-stage waterfall process including: (1) literature review and pilot study; (2) quantitative analysis of case study data; and (3) qualitative data collection via a focus group. Our research underscores the need to advise clients and their representatives of the importance of understanding the scope of works allowed within a tender submission before discounting it based solely on price. In addition, we highlight the failings of competitive tendering, which results in increased costs and project duration once the works commence on site. These findings provide new contemporary insight into procurement and tendering in the construction industry, with emphasis on SME contractors, existing relationships, and open-book negotiation. This research illustrates the adverse effects of early cost estimates produced without first securing a true understanding of project buildability and programming. Our work concludes with a novel insight into an alternative procurement option that involves early SME contractor involvement in an open-book environment, without the need for a third-party cost control.

Keywords: UK construction; tendering and procurement; rework; "race to the bottom"; negotiation; predicted cost

1. Introduction

Following the Joint Contracts Tribunal (JCT')'s launch of the Design and Build (D&B) form of contract in 1981 [1], the UK construction industry has moved away from traditional procurement routes involving bills of quantities and designs complete to RIBA Stage 4—Technical Design [2,3]. Instead, construction professionals and clients have opted for single-stage or two-stage competitive D&B tendering, with an often- incomplete design to RIBA stages 2 or 3 viz: Concept Design or Developed Design, respectively [4]. This approach embeds ambiguity within the scope of works included in the tender documents, due to a lack of design information [5]. Consequently, the project requirements are largely defined and delineated by the contractors' interpretations [6], thus increasing the difficulty of levelling bids, especially due to the inclusion of qualifications that form the basis of the tender return [7,8]. In addition, this approach reduces the clarity of procuring a contractor who has fully understood and allowed for the full extent of the scope of the works [9]. This lack of clarity in terms of scope, and the inherently competitive element of this procurement route, compel contractors to strategically plan their approach to each tender in order to increase the appeal of their tender return [10] and participate in the infamous "*race to the bottom*" [11]. By producing an artificially low tender sum, contractors seek to improve their chances of being called for a post-tender interview [12]. However, this strategy encourages decisions to exclude work items and then use provisional or prime cost sums to reduce element costs, and/or value engineering of the specification in order to offer cheaper alternatives [13].

Lack of consistency across the bids is a major issue with this approach, because it becomes increasingly difficult for the professional quantity surveyor (PQS) to align bids and conduct a thorough tender adjudication [14,15]. In contrast, a traditional bill of quantities allows for much easier comparison, because it is a uniform document providing itemised, measured quantities [16]. Consequently, the process of comparing tenders often involves looking purely at the bottom-line figure and ignoring the contents allowed within them [17], thus contradicting the guidance set out in the JCT Tendering Practise Note 2017 [18]. Therefore, during tender negotiations, and following the commencement of works on site, the costs tend to increase significantly to reflect the true scope of the works [19]. For example, the Scottish Parliament building was originally budgeted for a contract sum of GBP GBP 40 million (UK Sterling) in 1999, but the final account settled in 2004 was a staggering GBP GBP 414 million [20]. Another notable example was the London Crossrail Programme, which saw an increase in the total sum of the various contracts from GBP GBP 14.8 billion in 2013 to GBP GBP 17.6 billion in 2018 [21]. Similarly, the Olympic Games' original construction budget was GBP GBP 4.2 billion in 2005 when the site preparation for the Olympic Park commenced, but the final construction costs were reported to be an astonishing GBP GBP 9.32 billion in 2011 [22,23].

Given this backdrop, this research reports upon a successfully negotiated project, as a contemporary vignette of a case study in practice that illustrates the palpable benefits that this approach has over the often unsuccessful competitively tendered procurement route. Specifically, this work uncovers the strategic decisions made by the contractor to improve the chances of securing the project, and answers the question: does a negotiated contract provide a better option (for the mutual benefit of all parties) than the competitively tendered contract? Such work adds much-needed modernity to the wider field of studies on the cost escalations involved in different types of procurement paths, but also offers invaluable insight into the actual cost variances experienced by a small-to-medium enterprise (SME)-sized contractor using a negotiated contract; case study research using SME contractors and real-life cost data is relatively scant in academic literature. Upon achieving these aims, associated objectives seek to generate renewed polemic discourse on the importance of defining and understanding the scope of works, reduce variations and improve cost certainty for all involved parties, and engender greater transparency in order to avoid disputes as projects progress—resulting in greater client satisfaction, increased contractor profitability, and enhanced value management.

2. Procurement and Tendering in the UK Construction Industry: A Review

The Royal Institution of Chartered Surveyors (RICS) [24] defines procurement as "the overall act of obtaining goods and services from external sources i.e., a building contractor", and tendering as "the bidding process to obtain a price and how a contractor is appointed." Over time, the process has adapted; originally being a mechanism to control various trades required to carry out construction works [25], it has developed into a system to capture and manage the client's needs (*ibid*). In the construction industry, procurement and tendering usually involves some form of competition [26]. In order to appoint the most appropriate contractor to carry out the works, various procurement routes have been developed [27]. Figure 1 presents a timeline showing the evolution of procurement in the construction industry.

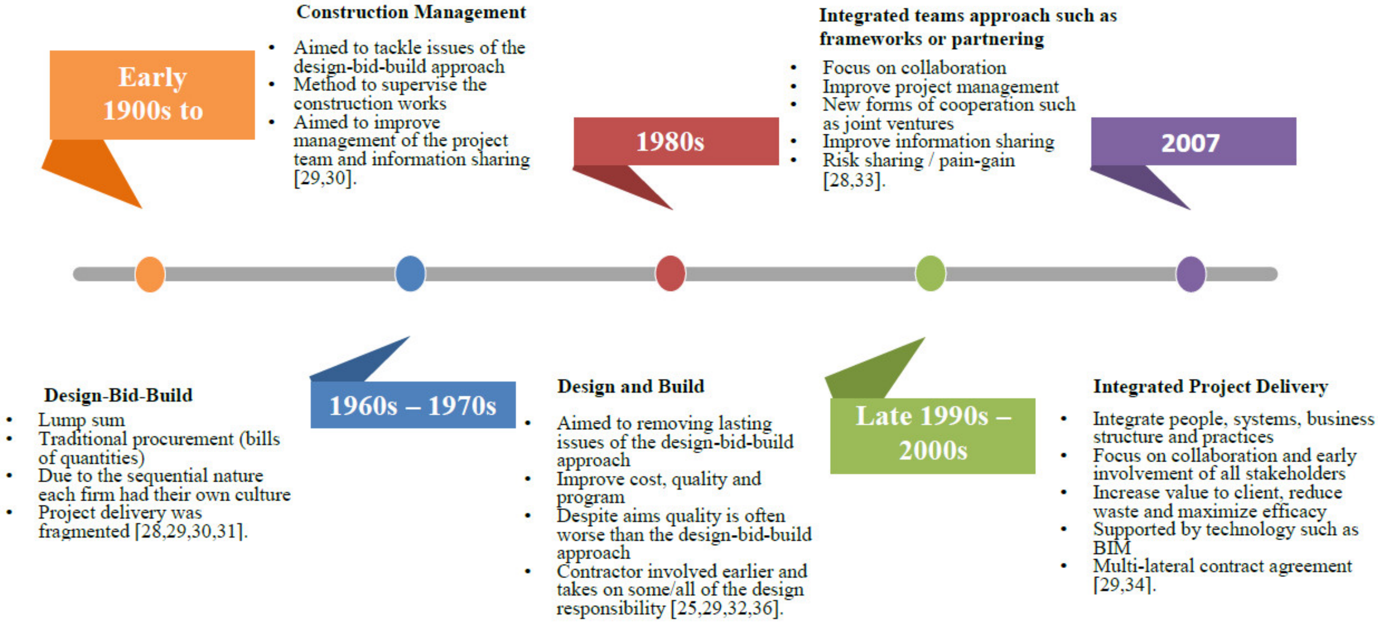


Figure 1. Timeline showing the evolution of procurement in the construction industry [25,28–35].

3. Preferred Tendering and Procurement Routes

The shift from traditionally procured projects towards D&B procurement routes is apparent from the National Construction Contracts and Law Surveys [35–37]. This trend can also be observed internationally [38]. In surveys carried out in 2012, 22% of consultants had been involved in D&B-procured projects [36], which increased to 37% [35] and 41% [37] in the 2015 and 2018 surveys, respectively. Contrastingly, consultants' involvement in traditionally procured projects was 72% in 2012 [36], and fell to 52% in 2015 [35] and 48% in 2018 [37]. These data highlight a clear shift in the preferred procurement routes in the UK construction industry; Naoum and Egbu [39] supported this view through their literature synthesis [40–42], concluding that there has been a particularly evident increase in D&B projects. The 2018 NBS survey showed 82% of participants as being involved in single-stage competitive tenders, 50% being involved in two-stage competitive tenders, and 50% in negotiations (*ibid*), highlighting an industry-wide preference for competitively tendered procurement routes [43].

4. Strategic Pricing Pre-Contract and Change Orders Post-Contract

During competitively tendered projects, Okada et al. [44] acknowledge that there has been an increase in contractors taking strategic pricing decisions and submitting artificially low/underpriced bids in order to win a project. This tactic is a common feature in the D&B procurement route and, consequently, changes to the contract sum are inevitable to reflect the true scope of the works [45]. Therefore, contractors rely on change orders and scope alterations as an opportunity to recuperate lost profits through cost increases for completing additional works [44]. Change can be perceived as any alteration to the scope, period, cost, and or/quality of the contracted works [46]. Although undesirable to the client, change is inevitable during construction works [45,47,48]. Hence, "change" and the subsequent cost increases [49] increase the contract sum to reflect the true value of the employer's requirements, as opposed to the scope allowed at tender stage [45]. The RIBA plan of works [50] outlines the *whole life cycle* of the construction process. The introduction of Stage 0—Strategic Definition was to further enhance the core design phases by confirming the client requirements (refer to Figure 2). The RIBA Plan of Work suggests that all design changes should occur from stages 1–4, with the exception of site queries at stage 5 [3]. However, current literature recognises that change often occurs during the construction phase and, therefore, there is a need to understand what the cause and effects of changes are, so that mitigation strategies can be adopted [51]. Table 1 summarises the sources of change during the construction phase, and the resultant effects are time, cost, or quality alterations to the project parameters [46].

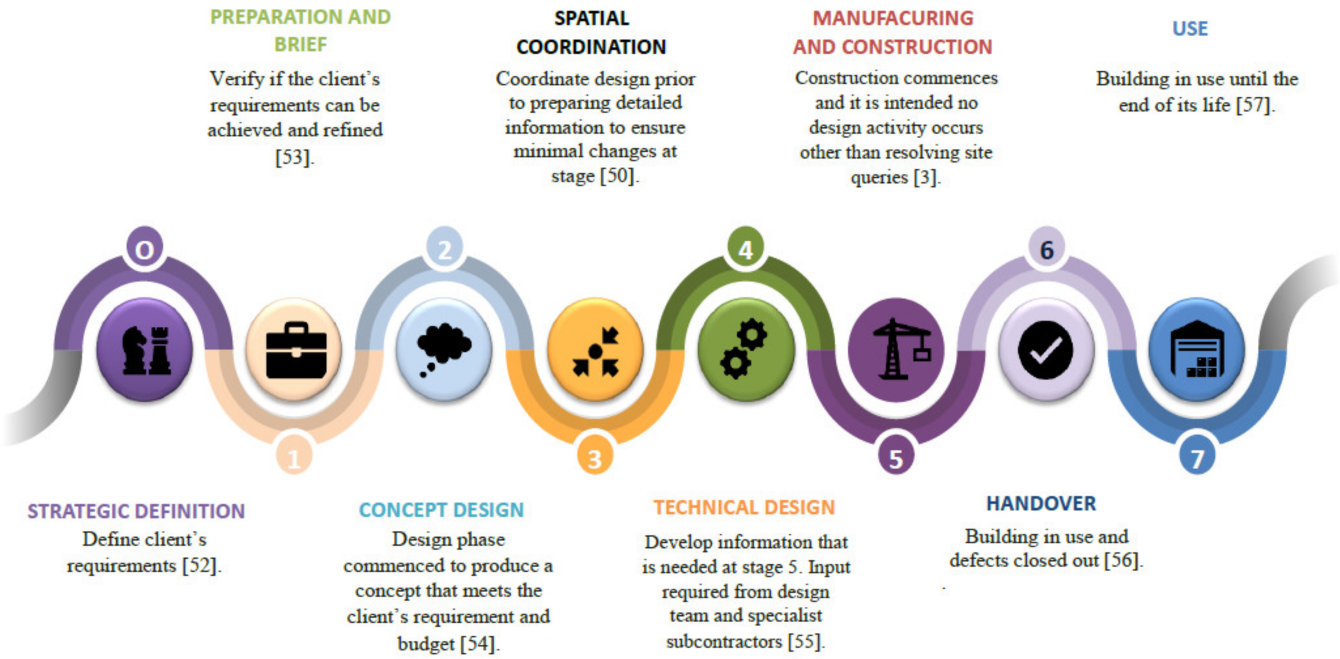


Figure 2. RIBA Plan of Work 2020 design involvement/responsibility [3,50,52–57].

Table 1. Sources of change during the construction phase.

Source of Change	Description of the Source	Reference
Design errors	Oversights, mistakes, and inaccuracies in the design information that forms part of the contract documents. Resulting in revisions of the drawings therefore allowing the contractor to claim for the cost of the additional works.	[44,58–62].
Design omissions	Design information lacking sufficient information to allow the full extent of the project to be costed. Therefore, adding in the omissions at a later date is supplemented by cost increases.	[44,58–62].
Client-driven	Changes requested / variation enquiries by the client that affect the time cost or quality of the project. Any change request provides the contractor an opportunity to revalue the item of works and submit a revised cost.	[44,58–62].

Changes to the scope of works	Changes to the contract documents i.e. contractor qualifications, clarifications or omissions resulting in additional work on top of the contractual works. This can include re-introducing items that had been excluded by the contractor or changes to design to allow the work to be physically carried out due to an oversight of the complexity and buildability during the design phase for example.	[58–63].
Design inconsistencies	Discrepancies in the contract documents i.e. fundamental differences between the architects and structural engineers drawing. This links to changes the scope of works as it is dependent on the contractor's clarifications as to what the costing was based on.	[58].
Managerial factors	Changes resulting from failings of the client's team. Including but not limited to: - Inaccurate cost estimates and advise to the client due to a lack of understanding of buildability - Design information not produced on time creating ambiguity - Inability to learn from passed experience and relying solely bottom-line comparison Poor communication and leadership to consolidate various stakeholders design inputs.	[58–60,63,64].
Unforeseen conditions	The 'unknown-unknowns' - Things that cannot be foreseen or accounted for i.e. force majeure or regulatory changes.	[44,59,61]

Smith et al. [49] concluded that the sources of change can be categorised under the overarching issue of a poorly defined brief and design during the project's early stages. This directly impacts contractors' tender submissions, therefore making change and cost increases during the delivery phase inevitable so as to correct the flawed project brief *(ibid).* Furthermore, the client consultant team are often out of their depth, with designers producing concepts that are not achievable in practice due to a lack of technical construction knowledge, and PQSs providing cost estimates without understanding or considering the sequencing and buildability of works *(ibid).* Consequently, early cost estimates produced for clients are often inaccurate and, thus, budgetary advice for the project is lower than the true cost of carrying out the works [65]. The concept of "rework" is applicable to this situation [62], which includes failure of the design team and cost consultants to produce a tender pack free from errors, omissions, and inconsistencies early in the project [66], during RIBA stages 2 and 3 [50]. Hence, had the client's consultants been more competent and produced an accurate brief [67], contractors would not have had to make strategic pricing decisions in order to submit the lowest price [68]. There is much discussion amongst academics regarding the effects of "rework". Love [66], as cited by Forcada et al. [58], states that rework contributes to 52% of total cost increases, and can range from 5% to 20% of the contract value. Analysis of 359 projects by Hwang et al. [69] concluded that rework costs added an extra 5% to the contract value and, similarly, Taylor et al. [61] found the average increase of change orders to be 4.53% among 610 contracts studied. Various other research studies have revealed that rework costs can account for up to 20% [62] of the contract value, with Fayek et al. [70] reporting 2–12%, and Oyewobi et al. [71] reporting 5.06% and 3.23% for new builds and refurbishments, respectively.

The main contractor is usually held accountable for the resultant increases in the final account caused by the changes, leading to worsened contractor–client relationships [72]. However, this is an inaccurate prognosis of a complex issue [63]. The reality supports the findings of Smith et al. [49] that the clients' team of consultants is at fault, while the contractor is merely the scapegoat for their failings. Therefore, Clause 2.12 of the JCT Design and Build Contract [73] applies, and any inadequacies found with the design are rectified—"*the employers' requirements shall be corrected, altered or modified accordingly*' and '*treated as a change*'". Under clause 5.2 regarding e*valuation of changes*, the contractor is entitled to the additional value of the work, and the contract sum increases to reflect this (*ibid*).

5. The Need for Change

Competitiveness is a recognised characteristic of the construction industry [74] and thus, procurement often takes place via competitive tendering routes, such as the D&B or design, bid, build approaches [75]. These routes often increase project duration, cost overruns, change orders, and rework, ultimately leaving the client dissatisfied [76]. Briscoe and Dainty [77] suggested that this was due to the vast number of stakeholders involved in construction projects, resulting in fragmentation and a lack of integration—a view supported by Harper et al. [78] and Papadonikolaki and Wamelink [79]. Project team members work almost exclusively on their portion of the works [80], further highlighting the fragmented environment created by these procurement routes [81]. To address the issues of competitive procurement routes, a cultural change is required in order to promote and incorporate collaboration [74,76].

The concept of integrated project delivery (IPD) was established in order to address these issues [82], by improving project efficiency through collaboration [81], therefore reducing the number of changes during the construction phase in order to avoid increased costs, whilst also seeking to offer cost savings and shorter durations [83]. Following its inception, surveys carried out suggested that competitive tendering was not an effective procurement method (*ibid).* Further studies showed that six projects that adapted IPD were able to successfully deliver or exceed the clients' requirements in terms of budget, programme, and design [84]. The research findings suggested that the reasons for success were due to traditional issues being avoided through enhanced collaboration and early involvement, therefore reducing ambiguity within the scope of the works. Early contractor involvement allowed for more realistic bids as the competitive element was removed (*ibid).* Collins and Parrish [45] support this position, arguing that early involvement of all project stakeholders (including the contractor) is more advantageous for offering cost certainty to the client. Figure 3 identifies an IPD team selection process using a case study project detailing how early stakeholder involvement and collaboration was achieved [85]. Despite the recognised benefits of IPD, it is not widely used in the UK construction industry [86]. This lack of adoption may contribute to projects that continue to be completed over budget and with extended durations. Arguably, IPD has not gained momentum due to its close relationship with building information modelling (BIM), and the associated barriers to entry this presents (*ibid).* Other barriers are defined in Figure 4.

Figure 3. Integrated project delivery (IPD) selection process [26,34,85,87–91].

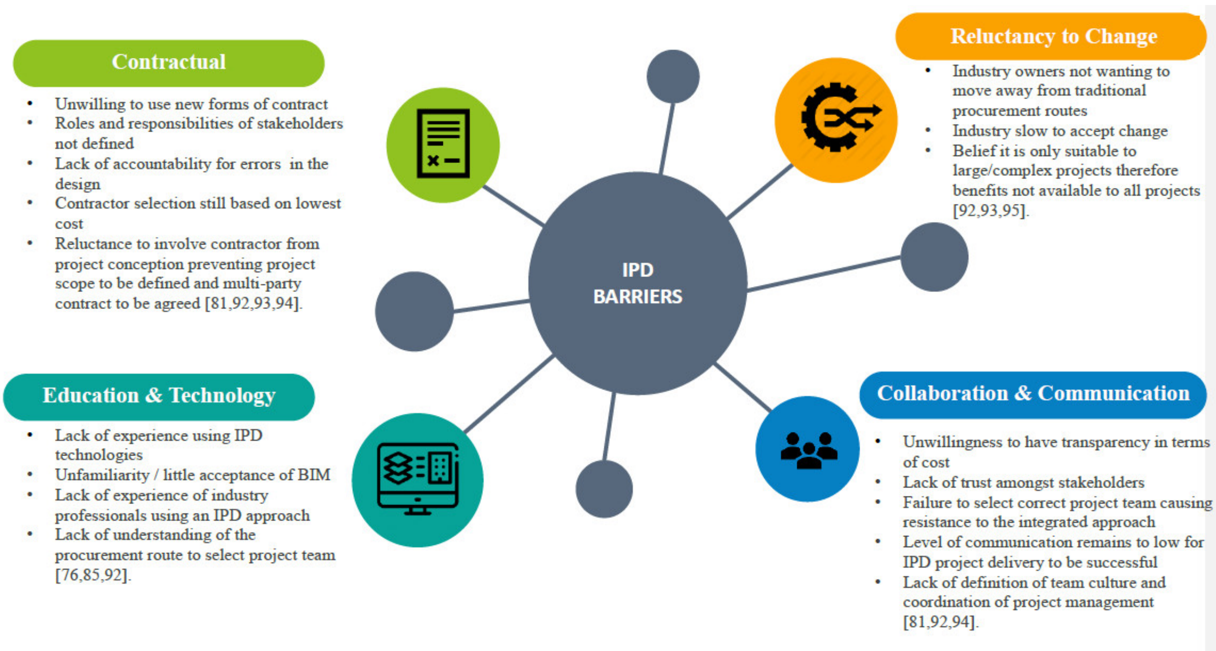


Figure 4. Barriers to integrated project delivery (IPD) [76,81,85,91–95].

Due to these barriers, an alternative tender and procurement route is required in order to avoid the *"lowest price wins"* scenario [85], which does not achieve best value or successful project delivery for the client [92]. There appears to be a notable gap in current literature exploring negotiation as a procurement route to achieve the desired cost certainty by avoiding contractors' strategic low-pricing tactics; hence, the rationale for this research.

6. Research Methodology

This research adopts a mixed philosophical stance that combines interpretivism [96–98] and pragmatism [99]. As an epistemological stance, interpretivism was adopted in order to critically review extant literature and generate questions that then informed the ensuing inductive research approach, which sought to generate new theory on "negotiation" as a viable procurement path [100]. Interpretivism has been extensively used within construction management and civil engineering research [101–103]. For example, Roberts et al. [104] reviewed the benefits and challenges of digital asset management, while Al-Saeed et al. [105] sought to automate construction manufacturing procedures using building information modelling (BIM) digital objects. Pragmatism [106] was adopted in order to analyse practitioner perceptions and values, so as to resolve the phenomena under investigation. This overarching epistemological design was contextualised within a case study strategy [107]—specifically, a successfully secured and delivered negotiated project wherein the main contractor was not responsible for the design. The project consisted of a new-build swimming pool and gym at a private dwelling with a floor area of 125 m^2. The main contractor (which was an SME) was based in Birmingham, UK, and operates mainly in the West Midlands conurbation, undertaking work in various sectors, including industrial, residential, commercial, and private dwellings. The contractor employs only 10 people, and has an annual turnover of circa GBP GBP 5 million—this research therefore gives a rare glimpse of project costings as experienced by an SME contractor. The research method follows a waterfall process, using three key phases consisting of: (1) literature review and pilot study; (2) quantitative analysis of the case study data; and (3) qualitative data collection using a focus group (Figure 5).

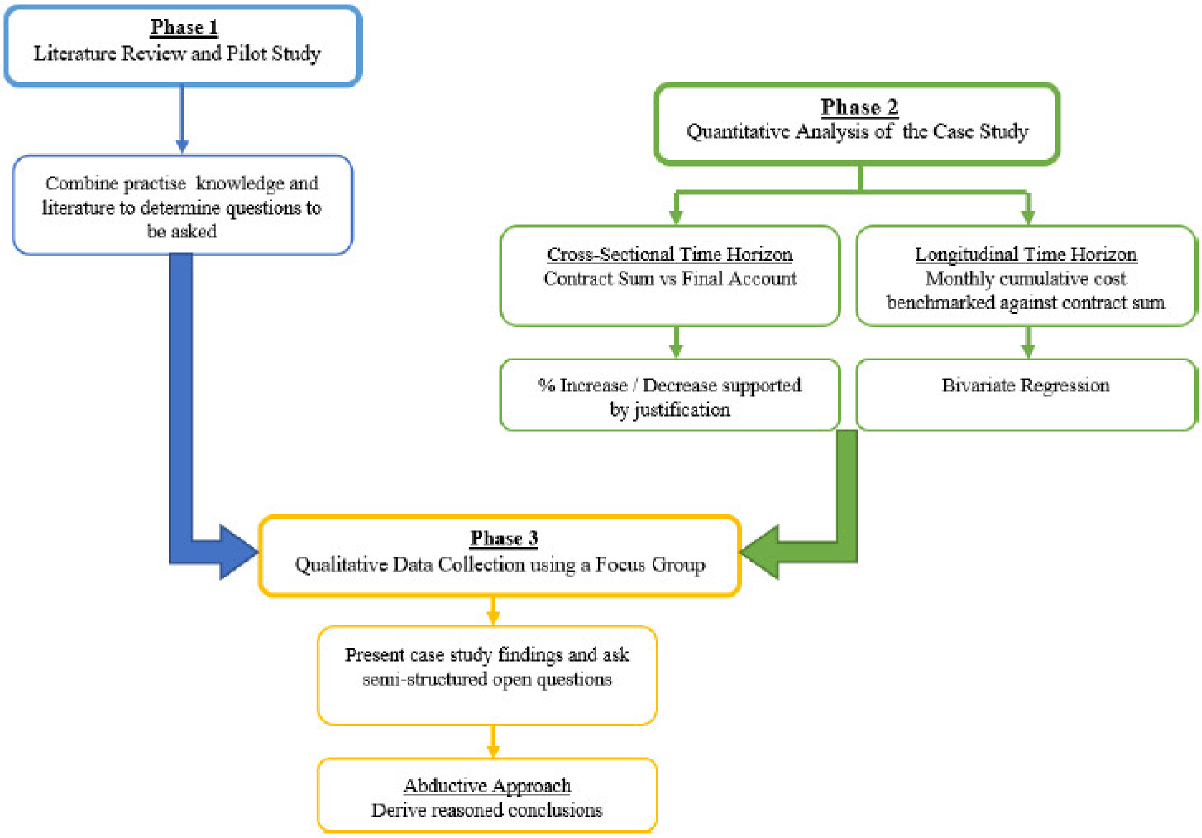


Figure 5. Waterfall research methodology.

Phase 1—Literature review and pilot study: Published literature on tendering and procurement was reviewed, and a pilot study convened with three professional practitioners (who also participated in the focus group), in order to assess the failure of competitive tendering and the need to develop a more successful procurement route for SMEs. During these discussions, findings from the literature were presented to pilot study participants in order to: (1) elicit professional practitioner feedback and guidance on the relevance and currency of the body of knowledge accumulated for the present study; (2) secure their insight on the key questions that should be posed and the types of data that should be collected in order to allow a robust analysis to commence; and (3) check on the validity of both the approach adopted and the scientific instruments used (such as for data collection). At the end of the pilot work, minor modifications were made to the questions developed for the focus group, in order to remove any ambiguity.

Phase 2—Quantitative analysis of the case study data: The main contract works as described in the JCT Minor Works 2016 contract were to carry out the construction of a single-storey gymnasium and swimming pool. Works on site commenced on 7 May 2019, and practical completion was achieved in December 2019. The contract sum was GBP GBP 294,994, and the final account agreed at GBP GBP 325,118. Participant action research (PAR) was implemented by the lead researcher, who worked as part of the project team for the main contractor [108]. Throughout the project's duration, monthly valuations were compiled in order to track the costs incurred on site, including preliminaries, drawdown, main contract works, and variations. This process also provided the facility to track the anticipated final account against the contract sum. The valuations became the application for payment, with the final valuation forming the basis of the final account. Quantitative cost data were extracted from the valuation reports, and empirical research implemented in order to determine cost differences (e.g., anticipated versus actual values) for various elements of the construction works. Qualitative narratives described the variations in the valuations, and provided justification for cost changes. Bivariate regression was then used to highlight the relationship between the monthly cumulative cost growth and the project duration, and then benchmarked against the agreed contract sum.

Phase 3—Qualitative data collection using a focus group: Upon completion of the data analysis phase, the results were presented to a focus group (held on MS Teams) consisting of three professional practitioner participants who were involved in the project management team (refer to Table 2). Participants were required to have a minimum of five years of industry experience, so as to ensure that they held the required competence to discuss the phenomena under investigation. A semi-structured data collection instrument that contained open-ended questions sourced from Phases 1 and 2 was developed and used to gather data. Participants were invited to provide their opinions of: (1) tendering and procurement, and the reasons for changes; and (2) the procurement route used, and whether they deemed this to have been a factor influencing the success of the project. This abductive approach [109] allowed evidence to be drawn together in order to derive reasoned conclusions.

Table 2. Demographic profiles of focus group participants.

Participant	Position in Business	Years of Experience in Industry	Years of Experience in Current Position	Highest Qualification
A	Managing Director	35+	13 as MD and 7 prior to that as a regional director	MCIOB
B	Commercial Manager	23	3	BSc
C	Site Manager	32	20	CIOB (Level 4) and SMSTS

7. Analysis

Data analysis involved collecting all of the applications for payment (16 in total—including 2 within the final account) in the case study project and presenting the cost data in a spreadsheet in order to show the bimonthly cumulative growth for the construction works, preliminaries, overheads and profit, materials on site, and variations. In collecting the data, an arithmetic error was found from Application 1 to Application 7—a SUM formula included in the Excel application for payment document did not capture all of the costs intended. The main contractor identified this error and corrected it in Application 8. For this research, the arithmetic error has been corrected, and the data have been adjusted to reflect the true cumulative costs had the error not occurred.

Once the applications data were compiled into one spreadsheet, they were then sorted into subcategories (e.g., Prelims: Fixed; Prelims: Time-Related, etc.) and the various construction works elements, following the BCIS elements [110] showing the cumulative cost growth. Variations were allocated to the corresponding preliminary item or construction works element. This process highlighted five variations that formed new items of work that did not form part of the main contract. To avoid the anticipated versus actual cost data being skewed, two cost summaries of the applications for payment were produced: the first showing all cost data, including the variations classified as “Additional Works”; and the second excluding the “Additional Works” items, in order to allow cost versus value analysis (Tables 3 and 4).

Table 3. Cost data to show bimonthly cumulative growth.

		APPLIC ATION														FINAL ACCOUNT	
DESCRIPTION	**CONTRACT**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**APPLICA-TION**	**AGREED**
	SUM ESTIMATED COST	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**	**TOTAL**
Prelims: Fixed	£12,215.00	£648.00	£810.00	£810.00	£810.00	£1092.00	£1092.00	£5730.75	£7277.00	£7277.00	£7277.00	£7737.00	£9060.00	£9060.00	£11,706.00	£12,215.00	£12,215.00
Prelims: Time Related	£29,628.37	£2370.27	£4740.54	£7407.09	£9777.36	£12,443.92	£14,814.19	£17,283.22	£19,752.25	£22,221.28	£24,690.31	£27,159.34	£29,628.37	£29,628.37	£33,906.37	£33,906.37	£29,628.37
Prelims: adjustment to final account																−£509.00	−£509.00
0. Facilitating works	£3742.00	£3167.00	£3217.00	£3217.00	£3217.00	£3517.00	£3517.00	£3517.00	£3517.00	£3517.00	£3517.00	£3517.00	£3742.00	£3742.00	£3742.00	£3742.00	£3742.00
1. Substructure	£30,729.93	£6878.00	£15,900.41	£25,559.56	£28,579.56	£28,253.03	£28,253.03	£28,253.03	£25,290.17	£25,290.17	£25,290.17	£25,290.17	£25,290.17	£25,290.17	£25,946.92	£25,805.00	£25,245.00
2.1 Structural Frame	£1500.00	£0.00	£900.00	£1350.00	£1500.00	£1500.00	£1500.00	£1500.00	£1500.00	£1500.00	£1500.00	£1500.00	£1500.00	£1500.00	£1500.00	£1500.00	£1500.00
2.3 Roof Structure	£30,388.57	£1426.50	£1426.50	£2853.00	£5940.47	£10,720.47	£15,220.47	£21,369.11	£29,197.46	£30,669.76	£30,669.76	£30,669.76	£30,669.76	£30,669.76	£30,669.76	£30,670.57	£30,670.57
2.5 External Walls	£15,756.71	£0.00	£0.00	£0.00	£6684.60	£13,845.86	£14,209.61	£15,271.71	£15,271.71	£15,271.71	£15,271.71	£15,654.96	£15,654.96	£15,654.96	£15,654.96	£15,894.71	£15,894.71
2.6 Windows & External Doors	£27,994.00	£0.00	£0.00	£559.88	£0.00	−£199.80	£2039.72	£2039.72	£14,467.36	£17,534.83	£29,134.53	£29,134.53	£29,134.53	£29,134.53	£29,134.53	£29,142.00	£29,142.00
2.7 Internal Walls & Partitions	£22,386.10	£0.00	£0.00	£0.00	£232.16	£232.16	£348.24	£348.24	£1246.80	£11,772.41	£19,611.67	£22,085.77	£22,031.29	£22,031.29	£22,031.29	£22,166.10	£22,166.10
2.8 Internal Doors (Joinery)	£2159.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£50.00	£901.97	£1736.97	£1756.97	£1756.97	£1756.97	£2560.00	£2560.00
3.1 Wall Finishes	£5850.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£670.00	£670.00	£1715.00	£4150.34	£4485.34	£4485.34	£4485.34	£4610.00	£4610.00
3.2 Floor Finishes	£1310.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£220.00	£0.00	£1060.00	£1060.00	£1280.00	£1280.00	£1280.00	£1280.00
3.3 Ceiling Finishes	£11,237.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£1978.00	£3956.00	£6923.00	£10,167.50	£10,662.00	£10,662.00	£10,662.00	£10,662.00	£10,662.00	£10,662.00
4. FF&E	£400.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£200.00	£400.00	£524.30	£524.30	£650.00	£650.00
5.1 M&E	£54,859.00	£272.80	£272.80	£272.80	£272.80	£272.80	£272.80	£272.80	£16,367.70	£27,279.50	£38,191.30	£54,481.00	£57,208.95	£57,698.69	£57,698.69	£58,492.00	£58,492.00
5.11 Lightning Protection	£500.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
5.14 BWIC	£1000.00	£0.00	£0.00	£0.00	£0.00	£250.00	£250.00	£250.00	£200.00	£500.00	£750.00	£1000.00	£1000.00	£1000.00	£1000.00	£1000.00	£1000.00
8.2 Roads, Paths, Paving's & Surfacing's	£8760.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£70.00	£2577.50	£8670.00	£9130.00	£9130.00
8.3 Soft Landscaping	£500.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£1336.20	£1480.50	£2301.00	£2301.00
8.4 Fencing, Railings & Walls	£80.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£1406.19	£1406.19	£1486.19	£1486.19	£1486.19	£1744.00	£1744.00
8.6 External Drainage	£9593.00	£0.00	£6143.75	£6143.75	£6143.75	£7396.20	£7396.20	£7396.20	£7396.20	£7396.20	£7396.20	£7396.20	£7396.20	£8420.70	£10,040.70	£10,043.00	£10,043.00
8.7 External Services	£3825.00	£0.00	£2175.00	£2175.00	£2175.00	£2175.00	£2175.00	£2175.00	£2175.00	£2175.00	£2175.00	£2175.00	£2950.00	£3825.00	£3825.00	£3825.00	£3825.00
Additional Work 1: Extent																	

Building by 450 mm	£0.00	£0.00	£0.00	£0.00	£0.00	£656.06	£1180.90	£1180.90	£2361.80	£2361.80	£2361.80	£2361.80	£2624.23	£2624.23	£2624.23	£2639.00	£2639.00
Additional Work 2: Patio, shed base and supplies to outdoor kitchen	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£3362.14	£12,103.72	£13,179.60	£13,655.00	£13,655.00
Additional Works 3: Outdoor kitchen	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£4810.00	£6794.82	£6972.00	£6972.00
Additional Works 4: Outdoor kitchen foundation	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£820.48	£825.00	£825.00
Additional Works 5: Gravel to driveway	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£2230.00	£2230.00
Construction works adjustment to final account																£122.81	£122.81
OH&P	£20,581.03	£1107.19	£2668.95	£3776.11	£4899.95	£6161.60	£6922.33	£8144.57	£11,295.81	£13,699.01	£16,666.40	£18,727.58	£19,624.44	£21,296.15	£22,458.90	£23,045.52	£22,682.67
Material on site; Aqua panel & anti corrosive stud	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£15,000.00	£15,000.00	£7500.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
Material on site; paving slabs	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£3043.40	£3043.40	£0.00	£0.00	£0.00	£0.00
TOTAL	**£294,994.71**	**£15,869.76**	**£38,254.94**	**£54,124.18**	**£70,232.64**	**£88,316.29**	**£99,191.48**	**£131,710.24**	**£176,942.26**	**£203,828.67**	**£238,693.52**	**£271,149.01**	**£283,840.94**	**£302,598.06**	**£323,079.55**	**£330,319.08**	**£325,118.23**

Table 4. Cost data to show bimonthly cumulative growth (excluding additional work).

DESCRIPTION	CONTRACT SUM	APPLICATION													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
	ESTIMATED COST	TOTAL VALUE	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
Prelims: Fixed	£12,215.00	£648.00	£810.00	£810.00	£810.00	£1092.00	£1092.00	£5730.75	£7277.00	£7277.00	£7277.00	£7737.00	£9060.00	£9060.00	£11,706.00
Prelims: Time Related	£29,628.37	£2370.27	£4740.54	£7407.09	£9777.36	£12,443.92	£14,814.19	£17,283.22	£19,752.25	£22,221.28	£24,690.31	£27,159.34	£29,628.37	£29,628.37	£33,906.37
Prelims: adjustment to final account															
0. Facilitating works	£3742.00	£3167.00	£3217.00	£3217.00	£3217.00	£3517.00	£3517.00	£3517.00	£3517.00	£3517.00	£3517.00	£3517.00	£3742.00	£3742.00	£3742.00
1. Substructure	£30,729.93	£6878.00	£15,900.41	£25,559.56	£28,579.56	£28,253.03	£28,253.03	£28,253.03	£25,290.17	£25,290.17	£25,290.17	£25,290.17	£25,290.17	£25,290.17	£25,946.92
2.1 Structural Frame	£1500.00	£0.00	£900.00	£1350.00	£1500.00	£1500.00	£1500.00	£1500.00	£1500.00	£1500.00	£1500.00	£1500.00	£1500.00	£1500.00	£1500.00
2.3 Roof Structure	£30,388.57	£1426.50	£1426.50	£2853.00	£5940.47	£10,720.47	£15,220.47	£21,369.11	£29,197.46	£30,669.76	£30,669.76	£30,669.76	£30,669.76	£30,669.76	£30,669.76
2.5 External Walls	£15,756.71	£0.00	£0.00	£0.00	£6684.60	£13,845.86	£14,209.61	£15,271.71	£15,271.71	£15,271.71	£15,271.71	£15,654.96	£15,654.96	£15,654.96	£15,654.96
2.6 Windows & External Doors	£27,994.00	£0.00	£0.00	£559.88	£0.00	−£199.80	£2039.72	£2039.72	£14,467.36	£17,534.83	£29,134.53	£29,134.53	£29,134.53	£29,134.53	£29,134.53
2.7 Internal Walls & Partitions	£22,386.10	£0.00	£0.00	£0.00	£232.16	£232.16	£348.24	£348.24	£1246.80	£11,772.41	£19,611.67	£22,085.77	£22,031.29	£22,031.29	£22,031.29
2.8 Internal Doors (Joinery)	£2159.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£50.00	£901.97	£1736.97	£1756.97	£1756.97	£1756.97
3.1 Wall Finishes	£5850.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£670.00	£670.00	£1715.00	£4150.34	£4485.34	£4485.34	£4485.34
3.2 Floor Finishes	£1310.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£220.00	£0.00	£1060.00	£1060.00	£1280.00	£1280.00
3.3 Ceiling Finishes	£11,237.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£1978.00	£3956.00	£6923.00	£10,167.50	£10,662.00	£10,662.00	£10,662.00	£10,662.00
4. FF&E	£400.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£200.00	£400.00	£524.30	£524.30

5.1 M&E	£54,859.00	£272.80	£272.80	£272.80	£272.80	£272.80	£272.80	£272.80	£16,367.70	£27,279.50	£38,191.30	£54,481.00	£57,208.95	£57,698.69	£57,698.69
5.11 Lightning Protection	£500.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
5.14 BWIC	£1000.00	£0.00	£0.00	£0.00	£0.00	£250.00	£250.00	£250.00	£200.00	£500.00	£750.00	£1000.00	£1000.00	£1000.00	£1000.00
8.2 Roads, Paths, Paving's & Surfacing's	£8760.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£70.00	£2577.50	£8670.00
8.3 Soft Landscaping	£500.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£1336.20	£1480.50
8.4 Fencing, Railings & Walls	£80.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£1406.19	£1406.19	£1486.19	£1486.19	£1486.19
8.6 External Drainage	£9593.00	£0.00	£6143.75	£6143.75	£6143.75	£7396.20	£7396.20	£7396.20	£7396.20	£7396.20	£7396.20	£7396.20	£7396.20	£8420.70	£10,040.70
8.7 External Services	£3825.00	£0.00	£2175.00	£2175.00	£2175.00	£2175.00	£2175.00	£2175.00	£2175.00	£2175.00	£2175.00	£2175.00	£2950.00	£3825.00	£3825.00
~~Additional Work 1: Extent Building by 450 mm~~	£0.00														
~~Additional Work 2: Patio, shed base and supplies to outdoor kitchen~~	£0.00														
~~Additional Works 3: Outdoor kitchen~~	£0.00														
~~Additional Works 4: Outdoor kitchen foundation~~	£0.00														
~~Additional Works 5: Gravel to driveway~~	£0.00														
Construction works adjustment to final account															
OH&P	£20,581.03	£1107.19	£2668.95	£3776.11	£4899.95	£6161.60	£6922.33	£8144.57	£11,295.81	£13,699.01	£16,666.40	£18,727.58	£19,624.44	£21,296.15	£22,458.90
Material on site; Aqua panel & anti corrosive stud	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£15,000.00	£15,000.00	£7500.00	£0.00	£0.00	£0.00	£0.00	£0.00
Material on site; paving slabs	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00	£3043.40	£3043.40	£0.00	£0.00
	£294,994.71	**£15,869.76**	**£38,254.94**	**£54,124.18**	**£70,232.64**	**£87,660.23**	**£98,010.58**	**£130,529.34**	**£174,580.46**	**£201,466.86**	**£236,331.71**	**£268,787.21**	**£277,854.57**	**£283,060.12**	**£299,660.42**

7.1. Cross-Sectional Time Horizon (Based on Table 3)

The cross-sectional time horizon was completed in order to show the percentage increase or decrease of the various construction works elements, together with the reasons for these changes, as classified by the professional practitioners involved in the project (Table 5).

Table 5. Cross-sectional time horizon.

Description	Contract Sum	Final Account Agreed			% Error	Reason for Change
	Estimated Cost	Actual Cost	Variations	Total		
Prelims: Fixed	£12,215	£12,215	£–	£12,215	0.00%	No change
Prelims: Time Related	£29,628	£29,628	£–	£29,628	0.00%	No change (V036. removed from final account as agreed)
Prelims: adjustment to final account	£–	–£509	£–	–£509	New entry	Arithmetical error
0. Facilitating works	£3742	£3742	£–	£3742	0.00%	No change
1. Substructure	£30,730	£29,100	–£3855	£25,245	–17.85%	V02.Client-driven V06.Unforeseen conditions V034.Client-driven/change to scope of works
2.1 Structural Frame	£1500	£1500	£–	£1500	0.00%	No change
2.3 Roof Structure	£30,389	£30,389	£282	£30,671	0.93%	V08.Other-Material availability V012.Client Driven V016.Design error/omission
2.5 External Walls	£15,757	£15,757	£138	£15,895	0.88%	V07.Client-driven V09.Design error
2.6 Windows & External Doors	£27,994	£27,994	£1148	£29,142	4.10%	V05.Design error/omission
2.7 Internal Walls & Partitions	£22,386	£22,146	£20	£22,166	–0.98%	V010.Design error/omission V014.Design error V020.Change to scope of works
2.8 Internal Doors (Joinery)	£2159	£2159	£401	£2560	18.57%	V018.Client-driven V019.Change to scope of works V022.Client-driven
3.1 Wall Finishes	£5850	£5850	–£1240	£4610	–21.20%	V021. Client-driven V025.Client-driven/change to scope of works
3.2 Floor Finishes	£1310	£1060	£220	£1280	–2.29%	V013.Change to scope of work
3.3 Ceiling Finishes	£11,237	£10,662	£–	£10,662	–5.12%	False ceiling to steam shower Not required therefore, value not drawn
4. FF&E	£400	£400	£250	£650	62.50%	V027.Client-driven
5.1 M&E	£54,859	£54,859	£3633	£58,492	6.62%	V011.Client-driven V026.Client-driven

						V028.Client-driven V029.Design error/omission V030.Client-driven V035.2. Client-driven V037.Design error
5.11 Lightning Protection	£500	£–	£–	£–	−100.00%	Not required therefore value not drawn
5.14 BWIC	£1000	£1000	£–	£1000	0.00%	No change
8.2 Roads, Paths, Paving's & Surfacing's	£8760	£8010	£1120	£9130	4.22%	Construction of new brick bier and capping's not required therefore value not drawn V031.Client-driven V032.Unforseen conditions V035.3. Client-driven
8.3 Soft Landscaping	£500	£500	£1801	£2301	360.20%	V023.Other-provisional sum expenditure
8.4 Fencing, Railings & Walls	£80	£80	£1664	£1744	2080.00%	V015.Client-driven V035.1. Client-driven
8.6 External Drainage	£9593	£9593	£450	£10,043	4.69%	V03.Design error V04.Design omission
8.7 External Services	£3825	£3825	£–	£3825	0.00%	No change
Additional Work 1: Extent Building by 450 mm	£–	£–	£2639	£2639	New entry	V01.Client-driven
Additional Work 2: Patio, shed base and supplies to outdoor kitchen	£–	£–	£13,655	£13,655	New entry	V017.Client-driven V033.Change to scope of work
Additional Works 3: Outdoor kitchen	£–	£–	£6972	£6972	New entry	V024.A. Client-driven
Additional Works 4: Outdoor kitchen foundation	£–	£–	£825	£825	New entry	V024.B. Client-driven
Additional Works 5: Gravel to driveway	£–	£–	£2230	£2230	New entry	V038.Client-driven
Construction Works: adjustment to final account	£–	£123	£–	£123	New entry	Arithmetical error
OH&P	£20,581	£20,256	£2426	£22,683	10.21%	
TOTAL:	**£294,995**	**£290,339**	**£34,779**	**£325,118**	**10.21%**	**As discussed above**

Of the 30 categories, 6 saw no change from the contract sum to the final account, 11 saw a percentage increase, s6 saw a percentage decrease, and there were 7 new entries in the final account that did not form part of the contract sum. Of the 7 new entries, 5 accounted for the additional work outside of the contract sum and 2 were due to arithmetic errors. The 5 items of additional works identified added GBP 26,321, which equates to 8.92% of the contract sum. Due to these items not being foreseen at the outset, there was no value allocated against them. The overall percentage error was 10.21%. The three professional practitioners (i.e., Commercial Manager, Site Manager, and Managing Director) involved in the project classified each variation with a weighting out of 100%. The occurrence for each response (without considering the weighting) was as follows: design error (19); design omission (13); client-driven (55); change to scope of works (31); managerial factors (3); unforeseen conditions (11); and other (2). Upon final allocation of the classifications, 5.5 were due to design errors, 2.5 to design omission, 20 were client-driven, 5 due to changes to the scope of works, 0 to managerial factors, 3 to unforeseen conditions, and 3 for other reasons. Conclusively, the main reasons for changes were client driven (at 51.28%).

7.2. Cross-Sectional Time Horizon (Based on Table 4)

The cross-sectional time horizon was repeated as described above in order to show the percentage increase or decrease supported by justification for variations, excluding the five additional works items (Table 6). Removing the additional works items resulted in 25 categories; as before, 6 categories had no change, 11 had a percentage increase, 6 had a percentage decrease, and there were now 2 new entries due to arithmetic errors in the final account. The overall percentage error was 1.29%. This low overall percentage increase suggests that cost certainty was achieved, as there was little variance from the contract sum to the agreed final account. A two-tailed paired sample *t*-test was completed on Excel. The null hypothesis under investigation was that the mean difference between the anticipated and actual costs would equal zero, and the alternative hypothesis was that the mean difference between the anticipated and actual costs would not equal zero. The *t*-test results were: *t*-statistic = 0.49 (2 dp); and critical *t*-statistic for two-tailed test = 2.06 (2 dp). Due to the fact that the *t*-statistic < the critical *t*-statistic, we can accept the null hypothesis. Therefore, the data suggest that the mean difference can equal zero, thus suggesting that cost certainty was achieved. The data were also used to calculate the mean difference, standard deviation of the difference, standard error of the difference, and the confidence intervals (Table 7).

Table 6. Cross-sectional time horizon (excluding additional work).

Description	Contract Sum	Final Account Agreed			% Error	Reasons for Change
	Estimated Cost	Actual Cost	Variations	Total		
Prelims: Fixed	£12,215	£12,215	£–	£12,215	0.00%	No change
Prelims: Time Related	£29,628	£29,628	£–	£29,628	0.00%	No change (V036. removed from final account as agreed)
Prelims: adjustment to final account	£–	−£509	£–	−£509	New entry	Arithmetical error
0. Facilitating works	£3742	£3742	£–	£3742	0.00%	No change
1. Substructure	£30,730	£29,100	−£3855	£25,245	−17.85%	V02.Client-driven V06.Unforeseen conditions

						V034.Client-driven/change to scope of works
2.1 Structural Frame	£1500	£1500	£–	£1500	0.00%	No change
2.3 Roof Structure	£30,389	£30,389	£282	£30,671	0.93%	V08.Other-Material availability
						V012.Client Driven
						V016.Design error/omission
2.5 External Walls	£15,757	£15,757	£138	£15,895	0.88%	V07.Client-driven
						V09.Design error
2.6 Windows & External Doors	£27,994	£27,994	£1148	£29,142	4.10%	V05.Design error/omission
2.7 Internal Walls & Partitions	£22,386	£22,146	£20	£22,166	−0.98%	V010.Design error/omission
						V014.Design error
						V020.Change to scope of works
2.8 Internal Doors (Joinery)	£2159	£2159	£401	£2560	18.57%	V018.Client-driven
						V019.Change to scope of works
						V022.Client-driven
3.1 Wall Finishes	£5850	£5850	−£1240	£4610	−21.20%	V021. Client-driven
						V025.Client-driven/change to scope of works
3.2 Floor Finishes	£1310	£1060	£220	£1280	−2.29%	V013.Change to scope of work
3.3 Ceiling Finishes	£11,237	£10,662	£–	£10,662	−5.12%	False ceiling to steam shower Not required therefore value not drawn
4. FF&E	£400	£400	£250	£650	62.50%	V027.Client-driven
5.1 M&E	£54,859	£54,859	£3633	£58,492	6.62%	V011.Client-driven
						V026.Client-driven
						V028.Client-driven
						V029.Design error/omission
						V030.Client-driven
						V035.2. Client-driven
						V037.Design error
5.11 Lightning Protection	£500	£–	£–	£–	−100.00%	Not required therefore value not drawn
5.14 BWIC	£1000	£1000	£ -	£1000	0.00%	No change
8.2 Roads, Paths, Paving's & Surfacing's	£8760	£8010	£1120	£9130	4.22%	Construction of new brick bier and capping's not required therefore value not drawn
						V031.Client-driven
						V032.Unforseen conditions
						V035.3. Client-driven
8.3 Soft Landscaping	£500	£500	£1801	£2301	360.20%	V023.Change to scope of works
8.4 Fencing, Railings & Walls	£80	£80	£1664	£1744	2080.00%	V015.Client-driven
						V035.1. Client-driven
8.6 External Drainage	£9593	£9593	£450	£10,043	4.69%	V03.Design error
						V04.Design omission

8.7 External Services	£3825	£3825	£–	£3825	0.00%	No change
Construction works adjustment to final account	£–	£123	£–	£123	New entry	Arithmetical error
OH&P	£20,581	£20,256	£2426	£22,683	10.21%	
	£294,995	**£290,339**	**£8458**	**£298,797**	**1.29%**	**As discussed above**

Table 7. Summary of statistical data following *t*-test.

Statistic	Result
Mean Difference	£152
Standard Deviation of Difference	£1549
Standard Error of Difference	£323
½ T alpha 95% Confidence interval	2.06
Lower Confidence Interval	−£487
Upper Confidence Interval	£791

The data show with 95% confidence that the mean difference between the agreed final account (actual cost) and the contract sum (anticipated cost) is a mere GBP 152. This result suggests that cost certainty was achieved. The mean percentage error (MPE) and mean absolute percentage error (MAPE) were then calculated in order to provide comparison between the anticipated and the actual costs of the various elements of the works. For a comparison of actual versus anticipated costs, all "new entry" data items were omitted. To prevent the data from being skewed, the interquartile range (IQR = upper quartile (Q3)–lower quartile (Q1)) was calculated and an outlier test was completed using the following formula:

$$\text{High-value outlier} = Q3 + 1.5\ (IQR); \tag{1}$$

$$\text{therefore, } 18.57\% + 1.5\ (18.57\%) = 46.43\%$$

$$\text{Low-value outlier} = Q1 - 1.5\ (IQR); \tag{2}$$

$$\text{therefore, } 0.00\% - 1.5(18.57\%) = -27.86\%$$

The following outliers were identified and removed: 4. FF&E 62.5% (mean absolute percentage error (MAPE)); 5.11 Lightning Protection 100% (MAPE); 8.3 Soft Landscaping 360.2% (MAPE); 8.4 Fencing, Railings, and Walls 2080% (MAPE). Refer to Table 8 for the data for the outlier, MPE, and MAPE calculations.

Table 8. Outlier, MPE, and MAPE data.

DESCRIPTION	Contract Sum	Final Account Agreed			% Error	Absolute % Error	Notes
	Estimated Cost	Actual Cost	Variations £–	Total			
Prelims: Fixed	£12,215	£12,215	£0	£12,215	0.00%	0.00%	
Prelims: Time Related	£29,628	£29,628	£0	£29,628	0.00%	0.00%	
0. Facilitating works	£3742	£3742	£0	£3742	0.00%	0.00%	
2.1 Structural Frame	£1500	£1500	£0	£1500	0.00%	0.00%	
5.14 BWIC	£1000	£1000	£0	£1000	0.00%	0.00%	
8.7 External Services	£3825	£3825	£0	£3825	0.00%	0.00%	Q1
2.5 External Walls	£15,757	£15,757	£138	£15,895	0.88%	0.88%	

2.3 Roof Structure	£30,389	£30,389	£282	£30,671	0.93%	0.93%	
2.7 Internal Walls & Partitions	£22,386	£22,146	£20	£22,166	−0.98%	0.98%	
3.2 Floor Finishes	£1310	£1060	£220	£1280	−2.29%	2.29%	
2.6 Windows & External Doors	£27,994	£27,994	£1148	£29,142	4.10%	4.10%	
8.2 Roads, Paths, Paving's & Surfacing's	£8760	£8010	£1120	£9130	4.22%	4.22%	Mid-Point
8.6 External Drainage	£9593	£9593	£450	£10,043	4.69%	4.69%	
3.3 Ceiling Finishes	£11,237	£10,662	£0	£10,662	−5.12%	5.12%	
5.1 M&E	£54,859	£54,859	£3633	£58,492	6.62%	6.62%	
OH&P	£20,581	£20,285	£2426	£22,712	10.35%	10.35%	
1. Substructure	£30,730	£29,100	−£3855	£25,245	−17.85%	17.85%	
2.8 Internal Doors (Joinery)	£2159	£2159	£401	£2560	18.57%	18.57%	Q3
3.1 Wall Finishes	£5850	£5850	−£1240	£4610	−21.20%	21.20%	
~~4. FF&E~~	~~£400~~	~~£400~~	~~£250~~	~~£650~~	~~62.50%~~	~~62.50%~~	Outlier removed
~~5.11 Lightning Protection~~	~~£500~~	~~£0~~	~~£0~~	~~£0~~	~~−100.00%~~	~~100.00%~~	Outlier removed
~~8.3 Soft Landscaping~~	~~£500~~	~~£500~~	~~£1801~~	~~£2301~~	~~360.20%~~	~~360.20%~~	Outlier removed
~~8.4 Fencing, Railings & Walls~~	~~£80~~	~~£80~~	~~£1664~~	~~£1744~~	~~2080.00%~~	~~2080.00%~~	Outlier removed
	£293,515	**£289,774**	**£4743**	**£294,517**	**2.93%**	**97.80%**	

$$\text{MPE} = \frac{100\%}{n}\sum_{t-1}^{n}\frac{At-Ft}{At} \quad (3)$$

where n = the number of elements of the construction works; and $\sum_{t-1}^{n}\frac{At-Ft}{At}$ = the sum of the percentage errors. MPE = $\frac{100\%}{19}$ x 2.93; therefore, MPE = 0.15%.

$$\text{MAPE} = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{At-Ft}{At}\right| \quad (4)$$

where n = the number of elements of the construction works; and $\sum_{t=1}^{n}\left|\frac{At-Ft}{At}\right|$ = the sum of the absolute percentage errors. MAPE = $\frac{1}{19}$ X 97.80; therefore, MAPE = 5.15%.

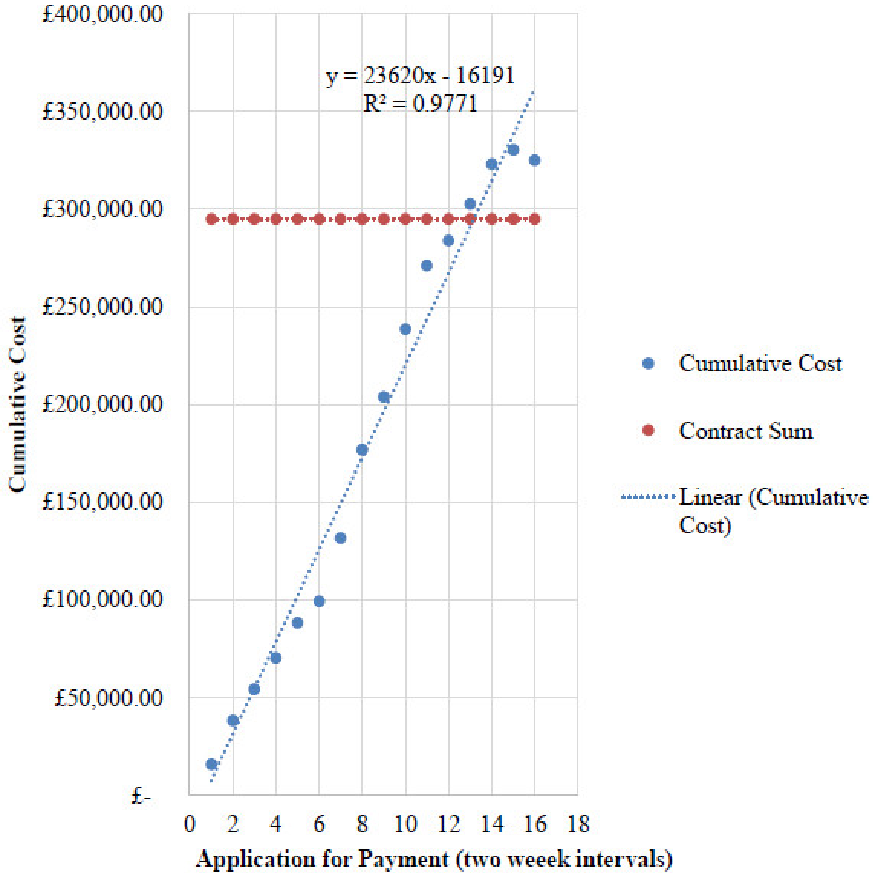
These results support the findings of the cross-sectional time horizon and the *t*-test. The final account was in line with the estimated costs and, on average, a 5.15% change to the package value was expected, while the average change in each element of the construction works was 0.15%, considering both positive and negative changes.

7.3. Longitudinal Time Horizon (Based on Table 3)

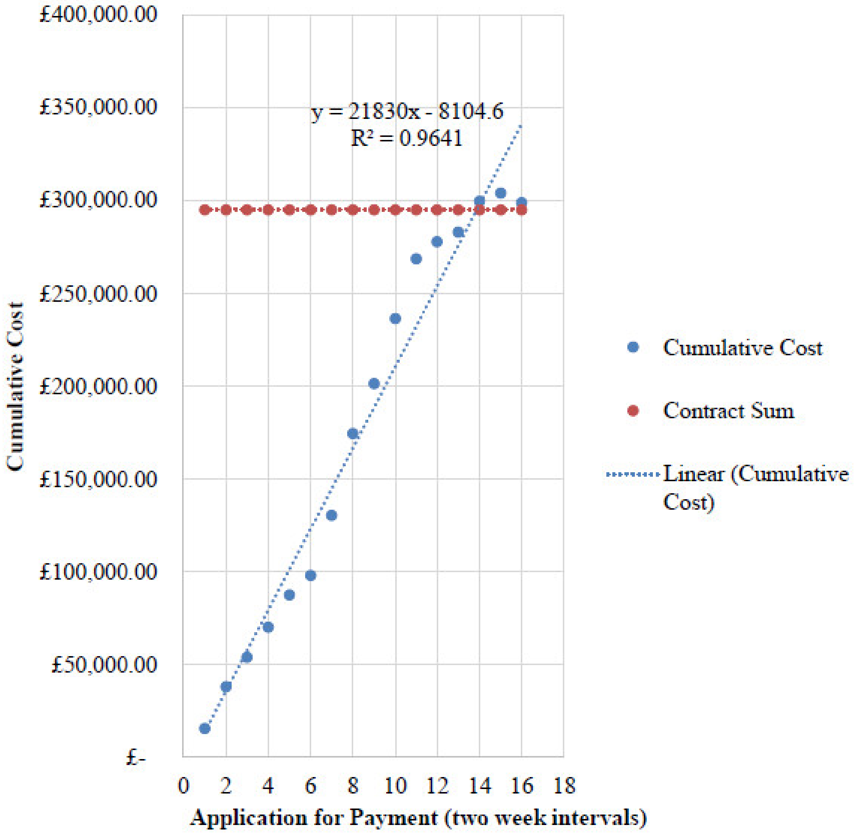
The longitudinal time horizon was modelled using bivariate regression, in order to show the cumulative cost growth for each application for payment [111]. For the case study project, the independent variable was the application for payment (with each application equidistant at 2-week intervals), and the dependant variable was the cumulative cost growth. The regression module utilises the formula:

$$\text{Y} = a + bx \quad (5)$$

where Y is the dependent variable (i.e., cumulative growth); a is the Y-axis intercept; and bx is the gradient of the independent variable (i.e., application number). The cumulative cost growth at each application for payment was plotted along with the contract sum, in order to provide a benchmark from which to ascertain the point at which the actual cost exceeded the anticipated cost (Figure 6a).



(**a**)



(**b**)

Figure 6. (**a**) Longitudinal time horizon; (**b**) longitudinal time horizon excluding additional work.

The result produced a formula of: Y = −16,191 + 23,620x. This indicates that before an application for payment was made the cumulative cost growth is estimated at GBP −16,191. For the case study project, at the point x = 0, Y will also equal zero, as no work on site has been done.

The negative figure may represent the pre-construction and site setup costs incurred by the contractor, which will not be paid for until Application 1. The equation also estimates that for each additional application for payment the cumulative cost will increase by GBP 23,620 on average. Model accuracy was also tested using the root-mean-square error (RMSE) calculation, as shown in Equation (6):

$$RMSE_{fo} = \left[\sum_{i=1}^{N}\left(z_{fi} - z_{oi}\right)^2 / N^{1/2}\right. \quad (6)$$

where $\sum$ = summation; $(z_{fi} - z_{oi})^2$ = differences squared; and n = sample size. This value came to GBP 16,654.26, which is incredibly small in comparison to the overall costs involved in the project, and demonstrates a good cost fit for the model.

The results also produced an R^2 of 0.9771, showing an extremely strong relationship between the cumulative cost increase and the bimonthly applications. The cumulative cost (actual) exceeded the contract sum (anticipated) during Application 13 of 16, and continued to rise until Application 15 before falling during Application 16—where Applications 15 and 16 represent the final account "application" and the "agreed" final account, respectively. Application 15 therefore represents what the contractor requested from the client, Application 16 represents what was agreed. The decline between Applications 15 and 16 reflects the final account negotiations, with Application 15 representing the contractor's final account submission at GBP 330,319, and Application 16 showing the agreed final account at GBP 325,118 (a reduction of GBP 5201). The final account exceeded the contract sum by 10.21% due to the cumulative effects of the reasons for change (Table 5).

7.4. Longitudinal Time Horizon (Based on Table 4)

A second longitudinal time horizon was conducted excluding the "Additional Work", basedon Table 4. This allowed analysis of the data without their being skewed by items that were not considered when the contract was agreed (Figure 6b).

The result produced a formula of: Y = −8104.60 + 21,830x. This indicates that before an application for payment was made the cumulative cost growth was estimated at GBP –8104.60. Again, when x = 0, Y will also equal 0 due to no work having been completed on site. The RMSE grew slightly to GBP 19,427.59 but, again, this figure is incredibly small compared to the overall project costs involved—again demonstrating a good cost fit for the model. However, the equation estimates that for each additional application for payment, the cumulative cost will increase by GBP 21,830 on average. With an R^2 of 0.9641, an extremely strong relationship between the cumulative cost increase and the bimonthly applications is evident. The cumulative cost (actual) exceeded the contract sum (anticipated) during Application 14 of 16. The cumulative cost continued to rise in Application 15 and then fell during Application 16, reflecting the contractor's final account submissions and the agreed final account. The final account exceeded the contract sum by 1.29%, the reasons for which are explained in Table 6. This small increase in the contract sum suggests that cost certainty had been achieved. Figure 6b provides a visual aid showing the actual costs as marginally higher than theanticipated costs. Comparing Figure 6a with Figure 6b, the gap between the cumulative cost and the contract sum is much greater in Figure 6a than Figure 6b.

8. Focus Group Discussion

A focus group session was established to discuss the analysis results with the three members of the project management team. A Microsoft PowerPoint presentation summary of the literature review and data analysis was delivered by the lead researcher. A series of investigative open questions were then delivered to the group (except for participant B, who provided responses via e-mail); the questions posed are detailed in Table 9. The first three questions investigated tendering and procurement generally. Unanimously, participants agreed that the main factor for contractor selection is "*cheapest price*", with participant A suggesting "*9 times out of 10 you will be driven by the costs*" and participant B simply stating "*price.*" When prompted on other factors, such as the scope of works, participant A confirmed that the price took precedence over this, saying "*unfortunately they go straight to the bottom line and will make a decision to interview on that basis. It doesn't always mean that's the result when you have finished the post tender/pre-contract negotiation.*" This point is supported by previous studies, which found that the lowest price gets called to interview [12], that the bottom line is considered more than the scope of works [17], and that the price increases during the pre-contract negotiations [19].

Table 9. Focus group questions.

No.	Question	Prompts
1	• Based on your experience of tendering for work, what is the key determining factor for contractor selection?	• Price? • Understanding of the scope of works? Qualifications and clarifications? • Previous experience?
2	• Of the tenders you have been involved in, what is the most frequently used procurement route? • And why do you think this is?	• Traditional? Design and build? Construction Management / Management Contracting? IPD? • Cost certainty? Ease of levelling bids? Design and construction occur at the same time? Off load risk? Competence / incompetence of design team?

3	• During a competitively tendered project what strategies do you implement in order to increase the chances of being consider for the post tender Q&A process?	• Exclusions and clarifications to lower the overall tender sum? • Can provisional and prime cost sums be used strategically during the tender process? • How can ambiguity in the scope of works/design be used tactically to improve your position? • Raise TQ's and communication with client team? Examples?
4	• Based on your involvement in the case study project – what impact if any did the negotiated procurement route have on the project delivery phase?	• Communication? • Open book approach to variations? Contract/client relationship? • Project success – time cost and quality
5	• Excluding the additional work outside of the contract scope of works. The cross-sectional time horizon shows the contract sum increased by 1.29% to the final account. What influence did the negotiated procurement route and the contractor/client relationship have on this?	• Open book environment Cost certainty • No need to use variations to increase final account to true value of the works? • Scope of works correctly allowed for at tender stage? Profitable job from outset?
6	• Various elements of construction work saw percentage reductions from the contract sum to the final account. Why was this?	• Omission from the scope of works? Provisional sum expenditure? • Procurement route influence (project already profitable)? • Honest approach - win / win situation?
7	• The large value variations have been classified as additional works. Why were these items not allowed for at tender stage?	• Not included in scope of works? Client request / Change? • Excluded as the scope was ambiguous?
8	• Would you class the project delivery as successful and why?	• Time? • Cost? • Quality? • Client satisfaction? Profitability?
9	• What impact did the negotiated procurement route have on this?	• Communication? Open book?

Collaboration? Certainty for all parties?To test the hypothesis that the UK construction industry prefers competitively tendered design and build projects (as stated in the literature), a question was posed in order to ascertain the most frequently experienced forms of contracts. Participant A responded, "*single-staged competitively tendered D&B*", participant B said "*design and build*", and participant C said "*more recently most of the projects have been design and build.*" This reinforces the findings of the NBS surveys [35–37]. Participant B suggested the reason being "*there is a perception that the contractor takes all the risk (although this is a misconception)*", while participant A continued this discussion, suggesting that the client uses D&B to protect their position, as it becomes the contractor's responsibility to "*prove change is due to a lack of information, part of the clarifications or a client-changed requirement.*" They continued to say "*traditional-type contracts seem to have gone by the wayside.*"

The conversation continued to discuss strategies implemented during the tender process to improve the chances of being called for a post-tender interview. Participant A stated *"price what you see"*, however, if it is unclear, you can *"put in a different figure, move figures* below the line or try and reduce the cost." Participant B added *"exclusions and clarifications are always a good way to lower the price and make it more attractive."* This discourse concurs with Okada et al. [44], who found that contractors implement strategies to submit an artificially low price, which will inevitably result in changes to the contract sum to reflect the true scope of the works [45]. At this point, the discussion began to explore negotiation, and participant A suggested "the figures tend to be more aligned at the end of the job, than during a competitively tendered, all-risk D&B", therefore supporting the data analysis showing that cost certainty was achieved.

At this point, the conversation was directed towards the case study project. A question was posed regarding the impact of the negotiated procurement route on the project delivery. Key words and phrases from the participants included: "*communication*", "*close working relationships*", "*early contractor–client relationships*", and "*clearly defined scope of work.*" Consequently, once the works commenced on site, the project delivery was relatively easy, as there was minimal "*ambiguity*" and, therefore, the site only encountered "*minor changes but nothing of great consequence*" as described by participant C. Various elements of the construction work saw a reduction from the contract sum to the final account. Participants agreed that one contributing factor was that the project was set up well at the start and, therefore, the contractor was able to reimburse costs that were not expended vis-à-vis holding onto them. Participant A described the relationship as a "*collaborative relationship as opposed to the aggressive type of situation you sometimes find*", and participant B agreed the relationships led to an "*honest approach.*"

When discussing the reasons for change, participant A said *"a lot of the changes were due to additional works the client decided he wanted"*, and participant B agreed that change was largely due to "*client request.*" This supports the data analysis, as 20 of the 39 variations had been classified as client-driven. Participants agreed that the established relationships allowed management of change to be more "*informal*", which helped in maintaining good working relationships. Due to the proximity of the site to the client's residence, participant A suggested "*it could have been a monumental disaster having the client that close to site because he would be there every day wanting to change or tweak things, but it worked out alright in the end.*"

Upon discussion of the success of the project delivery, participant A said, "it was delivered well, the client was very happy, and the product is exactly what he wanted so from that perspective *it was extremely successful.*" From a site perspective, participant C also deemed the project to be successful; "*it finished well, and the client was over the moon with it.*" The scope of the works was clearly defined and, therefore, any ambiguity or requests for information related to changes were as described by participant C, who said "*The majority of RFIs were because we knew there was a variation coming*", and where things were not clear *"they were very quickly resolved."* Furthermore, participant A said "*The majority of change was the client requiring extras rather than change because the design was inadequate, or things hadn't been interpreted correctly, or that the tender documents weren't sufficient.*" These reasons are supported by Smith et al. [49], Love et al. [112], and Ashworth et al. [67]. In addition, the completed project resulted in a recommendation and another negotiated project for the contractor.

9. Discussion

This research case study has provided a novel insight into an alternative procurement route (i.e., the negotiated procurement path) adopted by an SME contractor, thus providing both theoretical and practical contributions to knowledge and practice. From a theoretical perspective, the negotiated procurement created an "open book" environment that fostered trust and good working relationships between the contractor and the client. This included good adjudication of tender submissions to facilitate a two-way transparent knowledge transfer between client requirements and construction risks identified by the contractor. For example, during the pre-contract phase, the client regularly attended the main contractor's office to review the proposals, including a line-by-line review of the scope of the works and the associated costs of each item of work. This contrasts with extant literature, which reveals that during a competitive tender period, the contractor's submissions do not cater for the full scope of works and, consequently, the costs are artificially low so as to improve the probability of securing the project. Thereafter, variations during the construction phase are used as a tool to bring the project back in line with the scope of the works required, whilst also seizing the opportunity to submit manipulated costs in order to increase the total cost over and above the actual value of the works.

From a practical perspective, this research underpins the importance of both clients and contractors firmly embedding the attributes of confidence, transparency, and trust in a project. All too often, an unnecessarily adversarial relationship transpires, in which both client and contractor place their own business priorities ahead of those of the other contract parties. However, by working in harmony with one another, such attributes were shown in this case study to better control costs and mitigate disputes for the mutual benefit of both parties. The project provided cost certainty for the client and secured another negotiated project for the contractor. Following the presentation of the case study data analysis, cost certainty was discussed during the focus group, and participant A stated that: *"without his changes the contract sum was ultimately almost the finite cost."* Importantly, the project did not involve a PQS or third-party cost control operative, but instead the negotiation was completed between the client and the contractor directly. This proved beneficial to the project, as the client was not subjected to inaccurate early cost advice. Extant literature identifies this as a failing of the tender process, as the estimates frequently fail to consider site conditions, sequencing, and buildability [49]. Consequently, the client and the contractor worked together to develop the scheme to meet the client's budget, programme, and desired end product. A possible difference is that the client was knowledgeable about construction works, and that it may not be advisable to remove the third-party cost control (via a PQS) for less knowledgeable clients.

This research study has two main limitations: First, the lead researcher and study participants worked for the main contractor. Consequently, there is a potential for bias, as the opinions and experiences of client-side construction professionals have not been explored; future work should seek to address this deficiency. In addition, a single case study is unable to draw inference to determine whether or not the findings are applicable to other similar projects or procurement routes. Future research should therefore seek to run a cross-comparative analysis across various projects and procurement paths, in order to determine whether the findings presented here are unique or generalizable.

10. Conclusions

The literature review and responses from professional practitioners confirm that the UK construction industry's (and those of other nations globally) current preference for competitive tendering and design and build fails to procure the most suited contractor to complete the project, subsequently leaving the client dissatisfied, the final account not reflecting the contract sum, and a vast number of variations. This scenario stems from inaccuracies in the early cost estimates, design issues, and contractors implementing strategic pricing tactics to secure work due to the "race to the bottom" culture instilled by this industry preference. Often, the determining factor for project success is based on cost, and yet, literature points towards recurrent issues of variations, rework and, ultimately, cost inflations [44,58,62]. This case study's findings (involving an SME contractor) illustrate cost certainty being achieved and, therefore, provide a novel alternative procurement route centred on relationships, the scope of works, and transparency among stakeholders. A number of the design changes took place during the tender period; this was an advantage of the negotiation, as the contractor was involved early and, therefore, items that were foreseen could be dealt with at the tender stage. Therefore, the majority of changes during the construction stage were client-driven variations. Subsequently, the contractor understood what the client wanted to achieve, and the client had clear visibility on what they were getting. During the focus group, however, it was discussed that early contractor engagement is not common enough. In addition, due to the limitations discussed, this route of negotiation may not be applicable in all situations.

In addition to cost certainty, the findings also underscore the client's satisfaction, due to the recommendation for another future project for the SME contractor. Consequently, the outcome of the project delivery was mutually beneficial, and provided value to the client. Ultimately, the research findings support current literature that has recognised a need for change. This research therefore provides a catalyst for further research into the failings of competitive tendering, in order to draw inference and produce new guidance with the view to making tendering, procurement, and project delivery more efficient.

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