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Held at Dauphine Université, Paris, 2-3 September 2010

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- Building technology
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The property industry

- Information technology
- Innovation in education and training
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- Alternative dispute resolution and conflict management
- Professional education and training

Peer review process

All papers submitted to COBRA were subjected to a double-blind (peer review) refereeing process. Referees were drawn from an expert panel, representing respected academics from the construction and building research community. The conference organisers wish to extend their appreciation to the following members of the panel for their work, which is invaluable to the success of COBRA.

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In addition to this, the following specialist panel of peer-review experts assessed papers for the COBRA session arranged by CIB W113

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Peter Ward   University of Newcastle, Australia

A comparative analysis of procurement methods used on competitively tendered office projects in the UK

Anywhere Muriro
School of the Built Environment, The University of Salford
Maxwell Building
Salford, Greater Manchester
M5 4WT
Anywhere.muriro@bamnuttall.co.uk

Gerard Wood
School of the Built Environment, The University of Salford
Maxwell Building
Salford, Greater Manchester
M5 4WT
g.d.wood@salford.ac.uk

Abstract

The proliferation of procurement methods used for construction projects has inevitably resulted in comparisons being made between the performances associated with each of them. The challenge for researchers in this field has been largely to do with how to compare procurement systems on a like-for-like basis.

In addition the focus of previous studies has tended to be mainly on the critical success factors as assessed at the post-contract stage with less consideration of the effective benchmarking or measurement of success used in assessing the differences between systems and projects. Because of the limitations in previous studies it is perhaps not surprising that, to-date, there seems to be no general consensus on the optimum procurement method to be adopted for similar construction projects.

With this in mind this paper compares empirical information related to the successful tender for procurement methods used in competitive tendering of office projects in the United Kingdom (UK). It uses numeric/quantitative indicators such as construction costs, construction speed, construction time and intensity of construction. Several research techniques were used to achieve this goal. The research data was obtained from the BCIS database. The tender analysis data gathered was grouped in frequency distribution tables to facilitate rigorous examination, checking, interpretation and statistical significance testing. Based on this synthesis the paper provides empirical evidence that design and build (D&B) tendered office projects performed better in terms

of construction costs, unit costs, construction speed and intensity of construction. This is despite the fact that projects tendered under D&B method were more complex, of greater value and larger than those tendered using traditional methods.

Keywords: Procurement methods, success factors, benchmarking, numeric/quantitative indicators.

1.   Introduction

The selection of the most appropriate procurement method is critical for both the client and other project participants as it is an important factor that contributes to the overall client's satisfaction and project success. This selection will be dependent upon a number of factors such as cost, time and quality which are widely considered as being the most fundamental criteria for clients seeking to achieve their end product 'at the highest quality, at the lowest cost and in the shortest time' (Hackett et al. 2007). The existence of a wide variety of procurement methods available to project developers on the market today has led to several comparisons being made on how the different procurement methods have performed at the end of the construction phase.

However, there is little evidence from literature reviewed of such comparisons being undertaken at tender stage. In addition previous comparisons tended to focus at comparing procurement methods at a single point in time and no regard was made to analyse differences and similarities over a period of time in order to get a greater understanding of trends in the observed data. Since many variables affect project performance during the execution phase the objective of this paper is to critically analyse construction time, construction speed, unit cost of construction and intensity of construction for new build office projects tendered using different procurement methods in the UK based on secondary quantitative data gathered by the Building Cost Information Service (BCIS).

Since project costs would naturally vary from place to place and the effects of inflation would mean that projects tendered some time ago would have different cost profiles to those that have been tendered more recently, the tenders used in this paper were rebased to a tender price index of 212 (2nd Quarter 2010) and further adjusted to a common location index of 122 representing the Greater London geographical area. Indexing was necessary in order to compare projects tendered in different locations during different years.

2.   Research methodology and process

The main goal of the research is to quantitatively analyse and compare the performance of procurement methods used in the tendering of office projects in the UK over the last six years. Several research techniques were followed to achieve this goal. The review of related literature helped to define and differentiate between the most commonly employed procurement methods adopted in the UK over the last decade.

Research data was obtained from the BCIS tender analyses data base. The data gathered was then grouped in frequency distribution tables to facilitate rigorous and effective interpretation, analysis, checking and statistical significance testing. As part of the analysis, univariate comparisons of procurement methods used were also undertaken.

2.1   Literature Review

Review of the literature indicates a plethora of research endeavours undertaken over the years aimed at trying to understand the benefits of project delivery systems/procurement methods that have been used in the last few decades. Both qualitative and quantitative research have been undertaken; Oberlender and Zeitoun (1993) quantitatively studied early warning signs of project cost and schedule growth, Pocock (1996) developed a method for measuring the impact of project integration on the performance of public sector projects, Bennett et al (1996) compared the cost, schedule and quality performance of design and build projects and design/bid/build projects recently built in the UK and Walker (1997) analysed construction time performance by looking at traditional versus non-traditional procurement methods.

Others like Sidwell (1982) used qualitative research methods to assess impact of client decision making upon construction process and project success. Ireland (1983) similarly analysed the impact of managerial action on cost, time and quality performance in building. Elhag et al (1998) compared average tender prices per square metre of management contracts, design and build contracts and traditional contracts.

What is common to previous research reviewed in this study is the importance given to time–cost relationships in the delivery of construction projects. There is a general recognition that construction time is a corner stone measure of project success. Recent literature reviewed also reflects a wide variety of approaches in dealing with the factors affecting construction durations for different types of projects.

There seems to be a general acceptance of the theory that due to the integration of design and construction time and cost savings are more likely to be achieved in design and build than in traditional procurement method. These theories have been used to develop hypotheses of this study.

Obvious gaps in previous research are the fact that pre-contract time – cost relationships utilising tender data seems to have been largely overlooked. While post contract studies undertaken at the end of construction projects are important in undertaking post mortem studies, pre-contract studies are key to an in-depth understanding of project performance attributes associated with procurement methods before the production process. In addition the focus of previous studies has tended to be mainly on critical project success factors post-contract with less consideration of the effective benchmarking or comparative analysis at tender stage in assessing the differences between systems and projects.

Because of the limitations in previous studies it is perhaps not surprising that to date there seems to be no general consensus on the optimum procurement methods to be adopted for similar construction projects.

With this in mind this paper empirically compares procurement methods used in tendering of office projects over a relatively long period of time in the United Kingdom (UK) using numeric/quantitative indicators such as construction costs, construction speed, construction time and intensity of construction. This is in line with the view that performance measurement should be an ongoing exercise involving regular collecting and reporting of information about efficiency and effectiveness of construction projects.

3.0 Data collection, main findings and interpretation

Tender data on new build office projects was obtained from the BCIS website. Since project costs would naturally vary from place to place and the effects of inflation would mean that projects tendered some time ago would have different cost profiles to those that have been tendered more recently the researcher rebased the tenders to a tender price index of 212 (2nd Quarter 2010) and further adjusted the tenders to a common location index of 122 representing the Greater London geographical area.

Out of 82 projects office projects downloaded from the BCIS website 33 were discounted from the analysis as they were either refurbishment/fit out/conversion/refurbishment type projects or lacked sufficient quantitative data that was required for the research. From the remaining 49 projects 35 were tendered using the D&B procurement method and 14 were tendered using the traditional method.

Contractor selection methods used was varied across the projects reviewed but selected competition was the most common method used (49% of the projects analysed) followed by open competition (37%), Negotiation (12%) and Two stage tender (2%) as represented in Figure 1 below.

Figure 1: Contractor Selection methods
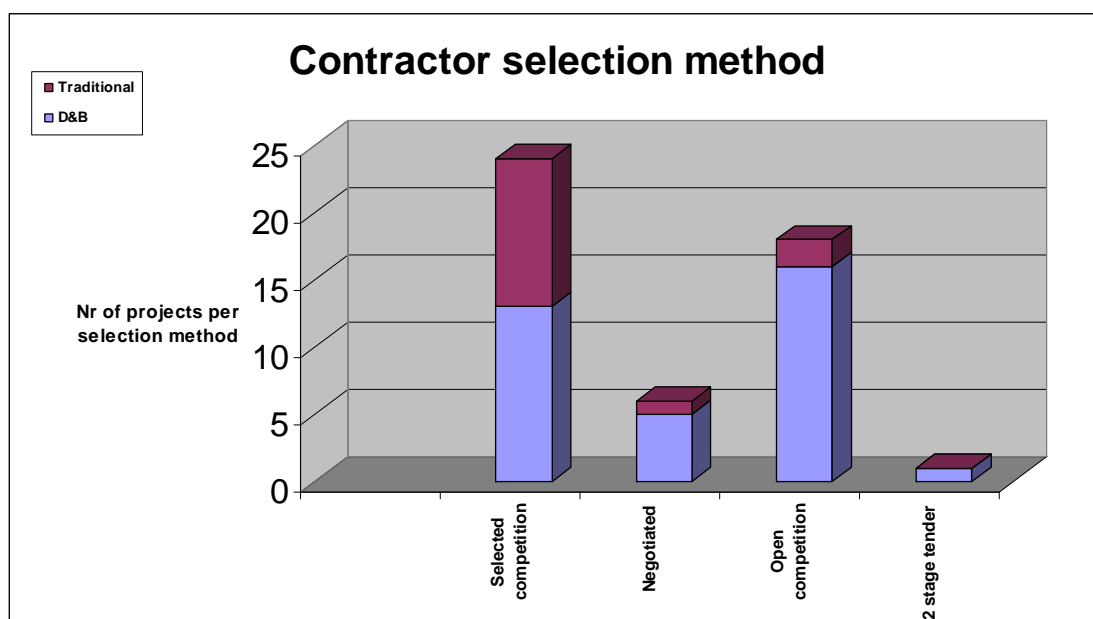
The specification for most of the projects reviewed is an average of three storey, reinforced concrete strip and pad foundation, steel frame, face brick/block walls and aluminium cladding.

The high percentage in competitive selection methods used in appointing contractors is in line with perceptions noted in the review of related literature in which clients are viewed as seeking to have their end products at the lowest price. Competition, whether selected or open, is perceived to generate this aspiration.

What is surprising from the research findings is that a larger proportion of D&B contractors were selected using open competition while a larger proportion of traditional contractors were selected using selected competition. It would appear from the literature reviewed that one of the reasons why the D&B delivery method has evolved over the years is an aspiration by clients to tap into the contractor's expertise in not only interpreting the employer's requirements but producing a design fit for that purpose. This being the case one would have expected clients to be selective on which contractor to choose for this key task.

Central tendency and variability characteristics of the research data was computed using univariate analysis. Univariate analysis was undertaken for construction costs, construction durations, construction speeds, unit costs, intensity of construction and gross floor areas of all projects under review and the results, classified by procurement method, is shown in Table 1 below.

Table 1: Summary of research results classified by procurement methods

Design & Build office procured projects						
Univariate tool	Construction costs (in £000's)	Construction duration (weeks)	Construction speed (m²/week)	Unit Cost (Cost/m²)	Intensity (cost/area /wk)	Gross Floor Area (in m²)
Median	2,786	43	53	1,134	26	2,690
Average	4,018	47	63	1,184	27	3,057
Standard deviation	4,316	18	38	353	8	2,330
Traditional method office procured projects						
Univariate tool	Construction costs (in £000's)	Construction duration (weeks)	Construction speed (m²/week)	Unit Cost (Cost/m²)	Intensity (cost/ m²/week)	Gross Floor Area (in m²)
Median	1,157	39	22	1,453	36	758
Average	1,683	41	29	1,413	40	1,311
Standard deviation	1,773	16	24	300	19	1,522

Construction cost in this research is defined as the tender cost of the office project represented by the winning tender sum. Unit cost and intensity are the two cost measures used to further analyse construction costs. Unit cost is defined as tender cost/gross floor area. Construction intensity is the unit cost of construction per unit time. Construction speed is the gross floor area/construction duration.

The null hypotheses postulated in the paper are that there are no differences in unit costs, construction speeds and intensity of construction for the 2 procurement methods while the alternative hypotheses postulated stated that there are differences in the performance metrics measured. Each sample mean for the 2 procurement methods was tested for comparison at a 95% confidence level (p=0.05). Therefore no significance is reported unless test values achieve this level of significance. Since one of the 2 samples used in this research is small (less than 30) and since the researcher wanted to test whether one mean of each of the procurement methods performance metrics is significantly higher or significantly lower than the other a one-tailed t test was deemed appropriate.

The null hypotheses were rejected in favour of the alternative hypotheses as the observed differences of the sample means of the 2 procurement methods were all found to fall outside the acceptance region of the critical t value. It can therefore be inferred from the research results that D&B tendered office projects achieved significantly lower unit costs than similar projects tendered through the traditional method. D&B tendered projects significantly outperformed tendered office projects procured using the traditional method with 63% of the D&B projects achieving scores over 60 m²/week compared to only 14% of the traditional projects. Significant differences in intensity of construction were also observed between the 2 procurement methods with over half of the office of the traditional projects scoring almost twice as much as their D&B counterparts.

3.1   *Unit costs of construction (Total tender cost/m²)*

Average unit costs for the projects reviewed were observed to be in the range £1,255 - £1,505/m²**.** This is the classification of unit costs in which the greatest number of projects analysed fall (in this case £1,255-£1,505) was classified as representing average unit cost range of the projects analysed. Unit costs below this range were classified as relatively low and those above the observed average range were classified as relatively high. Table 2 below tabulates the results.

Table 2: Unit cost of construction per procurement method

Unit costs						
Unit cost (cost/m²)	Design & Build (Nr of jobs)	% of all D&B projects	Traditional (Nr of jobs)	% of all Traditional projects	Total nr of all projects	As a % of Total of all projects
0-250	0	0%	0	0%	0	0%
251-501	0	0%	0	0%	0	0%
502-752	1	3%	0	0%	1	0%
753-1,003	10	29%	2	14%	12	0%
1,004-1,254	10	29%	2	14%	12	0%
1,255-1,505	10	29%	7	50%	17	0%
1,506-1,756	3	9%	1	7%	4	0%
1,757-2,007	0	0%	1	7%	1	0%
2,008-2,258	0	0%	1	7%	1	0%
+2,259	1	3%	0	0%	1	0%
Totals	**35**	**100%**	**14**	**100%**	**49**	**100%**

A summary of the unit cost classifications by procurement method is further tabulated below in Table 3 below.

Table 3: Unit costs by procurement method

Classification	% D&B projects	% of Traditional projects
Relatively low	60%	29%
Average costs	29%	50%
Relatively high	11%	21%

Similar observations were done for construction speed and intensity of construction. Similarly projects were classified as average, below and above average depending on the classification range. The findings for these performance metrics are presented in Tables 4 and 5 below.

3.2   *Construction speed*

Average construction speed for the projects reviewed was observed to be in the range of 21 - 41 m² per week. Any construction speed below this average was classified as relatively slow and any construction speed above this average was classified as relatively high.

Table 4: Construction speed by procurement method

Classification	% D&B projects	% of Traditional projects
Relatively slow	9%	50%
Average	29%	36%
Relatively fast	62%	14%

3.3   Construction intensity

Similarly average construction intensity range was observed to be £24-£29/ m²/week. Observed construction intensities lower than the averages were classified as relatively low and construction intensities higher than the average were classified as high. Table 5 below presents a summary of the results.

Table 5: Construction intensity by procurement method

Classification	% D&B projects	% of Traditional projects
Relatively low	29%	7%
Average	40%	29%
Relatively high	31%	64%

4.0 Interrelationships between observed attributes

In addition to identification and classification of research results as aforestated several time/cost/size relationships over the six year period of analysis were undertaken to gain more insight into interrelationships between observed project performance metrics and other attributes such as project size and year of tender. These relationships are presented below.

Figure 2: D&B - Relationship between project size & construction speed
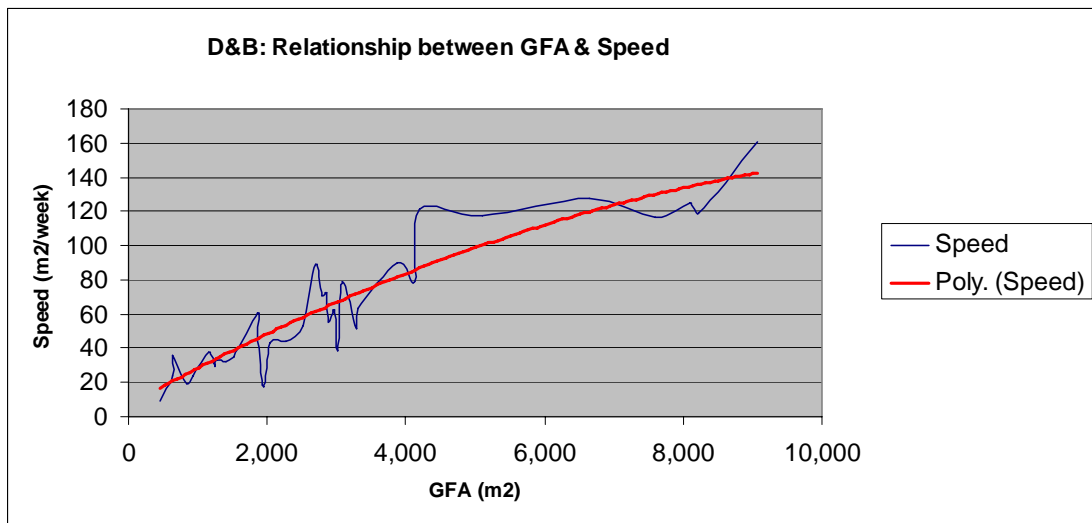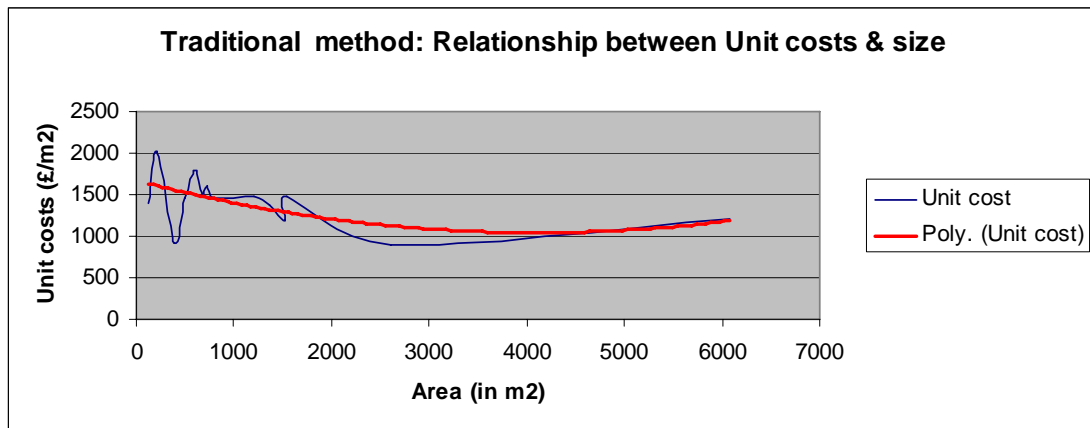

**Figure 3: Traditional: Relationship between project size & construction speed**
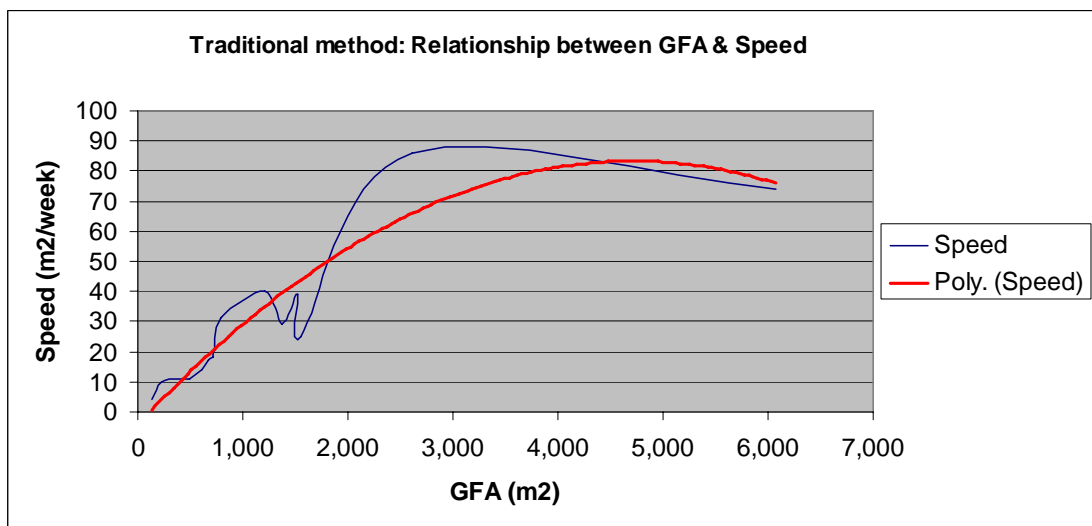
Construction speeds were observed to be significantly faster with increased project size on D&B tendered projects while on traditional tendered projects the relationship is not as significant. Further it can be observed that traditional projects above 5,500 m² in size start to achieve lower construction speeds than similar size projects procured through the D&B method.

Figure 4: Traditional method: Relationship between project size and unit costs

Traditional method: Relationship between Unit costs & size

Figure 5: D&B method: Relationship between project size and unit costs

D&B method: Relationship between Unit costs & size
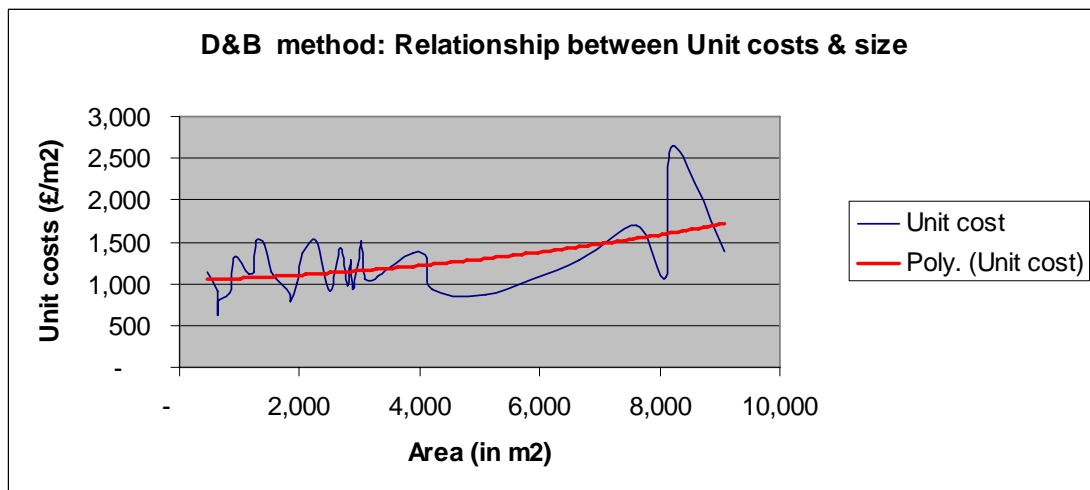
From the above graphical representations it would appear that unit costs gradually reduce with increased project size in traditionally procured projects while the trend is the opposite for D&B procured projects. This may be attributable to the perception that as projects increase in complexity and size unit costs increase as contractors employ sophisticated methods to deal with increased complexity.

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Figure 6: Traditional method: Relationship between year of tender and construction speed
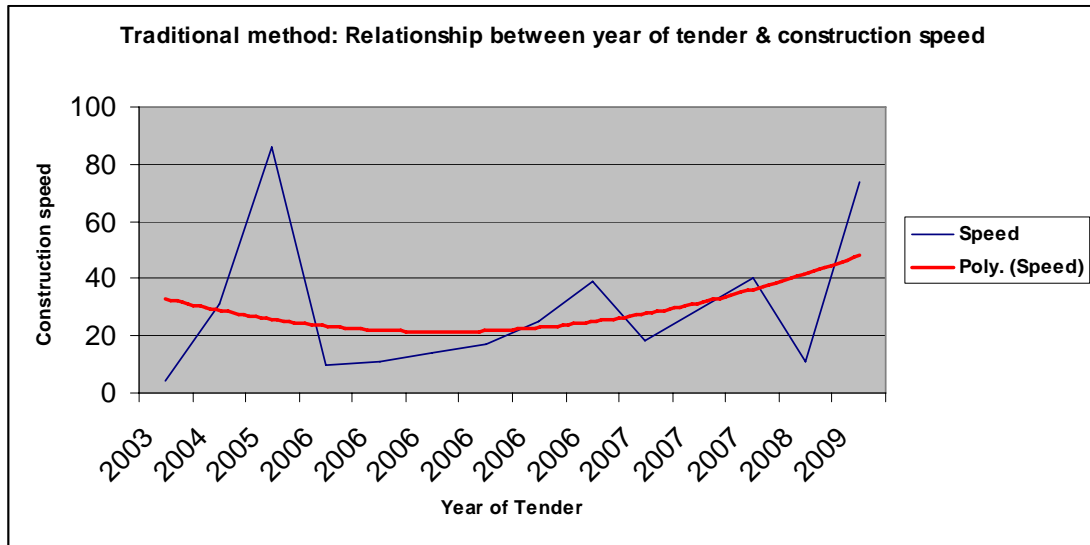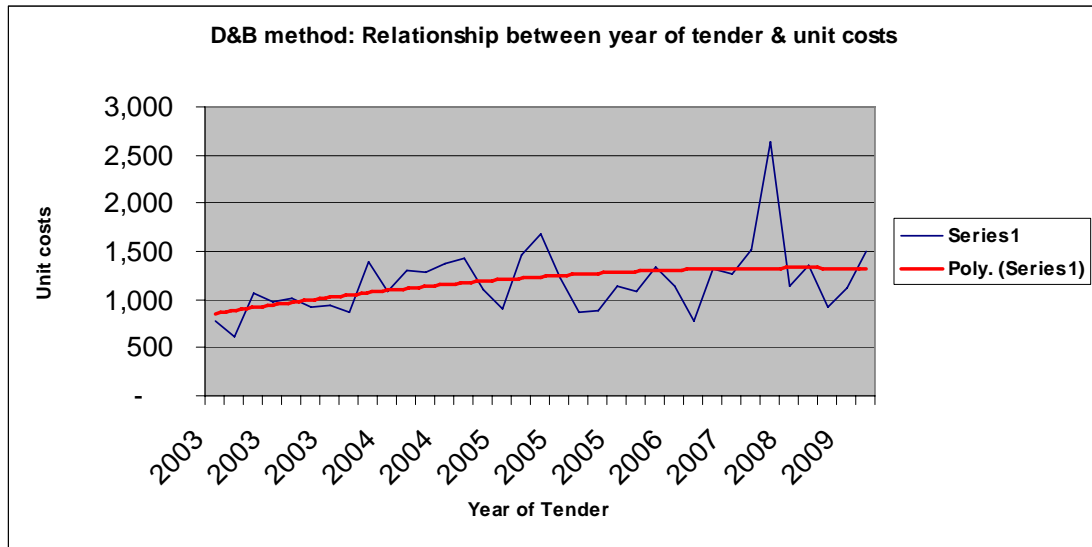

Figure 7: D&B method: Relationship between year of tender and construction speed
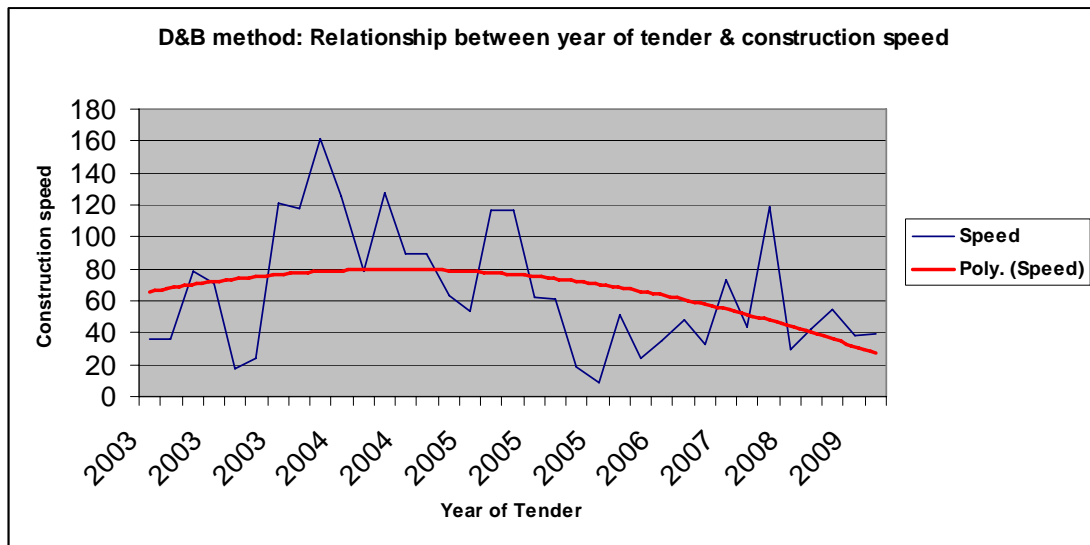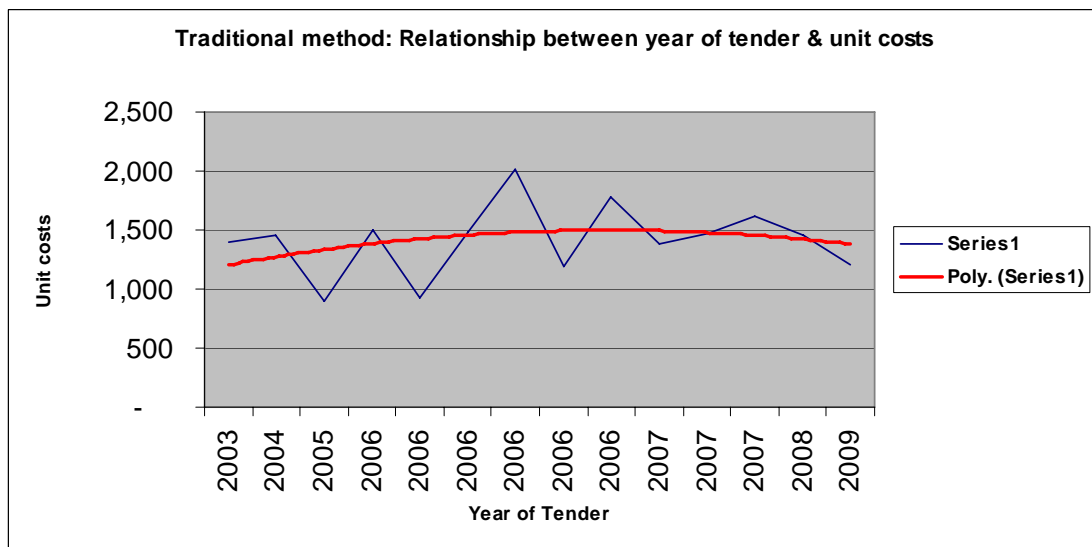

It can be observed from the above Figures 6 and 7 that while D&B tendered projects maintained a relatively steady trend up to the year 2005 and then dropping from late 2006 up to 2009 the trend was different in traditional projects where construction speeds were dipping from 2005 to 2006 but then started to increase from 2007 through to year 2009.

Figure 8: D&B method: Relationship between year of tender and unit costs

Figure 9: Traditional method: Relationship between year of tender and unit costs

From the above Figures 8 and 9 it can be observed that since 2003 unit costs for both procurement methods have been steadily increasing with the traditional procurement method showing significant increases up to 2007 and started to gradually drop in the period between 2008 and 2009.

5. Research limitations/implications

Data in this research was based on tender base information in terms of project construction costs and durations. The research therefore did not track changes post contract. Such changes play a key role in performance measurement of procurement systems in terms of cost growth and programme growth. Future research should therefore encompass not only the pre-contract project performance data but also post contract project performance data such as client satisfaction, cost predictability and time predictability associated with different procurement methods. In addition quality performance metric measurements were not taken into account which does have impacts on construction speed, intensity of construction and unit costs. Design phase durations were also not taken into account in the measurement of durations used in the research.

6. Practical implications

The selection of an appropriate procurement method is crucial to the successful performance of a construction project with regards to not only cost and time (as analysed in this research) but quality achieved as well. It also ensures a smooth project delivery process and eliminates problems during construction. The research provides comparative quantitative data that should assist project developers to make decisions on procurement strategy and methods. The fact that the research has used a longitudinal section of the sampled data (samples covering 6 years) means that the research results will help foster a better understanding of the role played by procurement method on cost and time attributes.

7. Conclusions

The research presented in this paper is part of an ongoing professional doctorate research to comparatively analyse performance of different procurement methods used to deliver office projects in central London in the last 5 years. Primary data based on a combination of mailed questionnaires and semi-structured interviews are currently being collected in order to address the overall aims and objectives of the main research.

The primary goal of this research however was to undertake a comparative analysis of different procurement methods used in successful tendered office projects in the UK over the

last 6 years commencing in 2003. To achieve this goal secondary data from the BCIS was categorised and examined. The research results presented indicate that D&B procured projects out performed traditional projects in terms of unit costs, construction speed and intensity of construction. This was supported by statistical tests performed on the research results. However using trend analysis further key findings and patterns were identified and presented graphically. This further analysis show that unit costs associated with traditional projects in the later parts of 2009 appear to be reducing to those levels that were observed in D&B projects. Similarly construction speeds for both D&B and traditional projects tendered in the later parts of year 2009 were not dissimilar. Again while unit costs for traditional projects gradually reduce with increased project size the effect is different on D&B projects whose observed unit costs seem to have been increasing with increase in project size.

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