LIFE CYCLE COSTING IN CONSTRUCTION PROJECTS: PROFESSIONAL QUANTITY SURVEYORS' PERSPECTIVE

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Abstract:

Studies on life-cycle costing (LCC) in private finance initiatives (PFI)/public-private partnership (PPP) projects abound, particularly in the UK. But, there is a limited empirical study on the factors influencing the usage of LCC outside PFI/PPP context from professional quantity surveyors perspective. The purpose of this study is to identify the barriers to greater use of LCC and explore the factors responsible for professional quantity surveyors' disposition to LCC usage in construction projects outside PFI/PPP context in the UK. The primary data were collected through a questionnaire survey administered to professional quantity surveyors working in consultancy practices of varying sizes in the UK. The data obtained were analysed using frequency distribution, relative significant index (RSI), Analysis of Variance (ANOVA) and Posthoc test. The study identified eleven barriers influencing the usage of LCC outside PPPs context. Thus, the five highest ranked barriers include: lack of fiscal measures that encourage clients' use of LCC; clients are unwilling to pay for LCC; incompatibility with client's intangible or non-financial objectives and needs; difficulty in obtaining the appropriate, relevant and reliable information and data; and clients do not request for LCC. The study further revealed that the majority of professional quantity surveyors are not directly involved in the use of LCC in their organisations. This study would be beneficial as knowledge of the factors influencing the professional quantity surveyors' disposition to LCC usage would enlighten quantity surveyors, clients and other stakeholders in the construction industry.

KEYWORDS: BARRIERS, CONSTRUCTION ORGANISATIONS, LCC, PROFESSIONAL QUANTITY SURVEYORS, UK.

1. INTRODUCTION

Life-cycle costing (LCC) plays a significant role in supporting economic and natural resource sustainability goals. For instance, International Institute for Sustainable Development (IISD) (2009) reports that integrating LCC into most especially procurement policies would provide the procurers with the opportunity to demonstrate that the best value for money across the asset life cycle can only be assured by purchasing green and socially preferable alternatives. Thus, it is obvious that LCC helps towards achieving economic sustainability. In overall, LCC enhances the sustainability performance. LCC originated from North America in the 1960s when its use in defense industry procurement was encouraged by the government (Ashworth & Hogg, 2000;

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TRADATechnology, 2008). In the UK, the then Department of Industry's Committee of Terotechnology started promoting LCC concepts in the 1970s (Woodward, 1997). However, the construction industry operates in an increasingly uncertain business environment, characterised by increasing competitiveness, resource scarcity, sustainability requirements, and demand for value for money by its stakeholders (Swaffield & McDonald, 2008; TRADATechnology, 2008). The built environment has wide-reaching economic and environmental implications: it is responsible for half of all CO2 emissions, half of water consumption, one-third of landfill waste, and one quarter of raw materials used in the UK (Woodward, 1997; Clift, 2003; BERR, 2008). As a result, there is mounting public interest and legislative requirement for sustainable construction, in addition to the need to conserve resources (Pasquire & Swaffield, 2002). There is growing pressure on those that design, produce and operate constructed assets to predict and manage the assets' whole life performance; it is no longer enough only to consider initial capital cost (Woodward, 1997; Clift, 2003; Flanagan & Jewel, 2005). There has been, therefore, a shift from addressing buildings 'as built' to 'in operation' (Pasquire & Swaffield, 2002; Clift, 2003; Kirkham, 2007; TRADATechnology, 2008). Various life cycle approaches are employed to assess asset performance for the entire life cycle from conception to decommissioning (Pasquire & Swaffield, 2002; Clift, 2003; Pelzeter, 2007).

Value improvement in the construction industry is imperative and will benefit all stakeholders in the industry such as the clients, contractors, consultants and the society as a whole (Ashworth & Hogg, 2000; Flanagan & Jewel, 2005). A number of novel techniques and practices which, if used properly, could lead to added value in design and construction of built assets have been proposed (Latham, 1994; Egan, 1997; Ashworth and Hogg, 2000; Kelly et al., 2002; Kelly et al., 2004). The Latham (1994) and Egan (1997) reports recommended LCC as a way through which the construction industry could deliver improved value for money (Pasquire and Swaffield, 2002). As the main promoter of LCC in the UK, the government considers value for money as 'the optimum combination of whole-life cost and quality to meet the users' requirements' (OGC, 2007). Previous studies on the use of LCC in the construction industry have been carried out from different professionals' perspective. For instance, Swaffield and McDonald (2008) investigate attitudes and opinions of quantity surveyors working for design and construction contractors regarding the use of LCC within PFI projects in the UK. In real estate professionals in Germany (Pelzeter, 2006 cited in Pelzeter, 2007), and a wider range of stakeholders in the construction industry in Sweden (Sterner, 2000) and the UK (Clift & Bourke, 1999). It is important to note that no studies on LCC use among professional/consultant quantity surveyors have been carried out yet. Indeed, there is need to find out how the professional quantity surveyors view LCC and explore ways in which their use of the technique can be improved. This necessitated a study on LCC in construction projects from professional quantity surveyors' perspective. Thus, the aim of this study is to identify the barriers to greater use of LCC and explore the factors responsible for professional quantity surveyors' disposition to LCC usage in construction projects outside PFI/PPP context in the UK. The results of this study would be very useful and beneficial to all stakeholders in construction industry, especially contractors'

quantity surveyors, clients, M&E engineers, facilities managers among others as value improvement in this sector is imperative.

Difficulties with LCC Application in Construction

The shortcomings of the LCC application in construction industry have been identified by a number of earlier researchers (Ashworth, 1996; Flanagan et al., 1989; Ferry & Flanagan, 1991; Bull, 1993) among others. For instance, Ashworth (1993) asserts that the acquisition of LCC knowledge and skills are still in its infancy, with a considerable gap between theory and practice. Arditi & Messiha (1996) state that in the United States 60% of the municipalities did not use LCC due to the following reasons: lack of formal guidelines, difficulty of estimating future costs and incomes, and criteria used in selecting projects for LCC implementation appear to be arbitrary. Kishk & Al-Hajj (1999) summarise the difficulties in the application of LCC as a decision-making tool in the construction industry on the parts of the client, the analyst and the industry practices. The difficulties on the part of the industry (i.e. construction industry) include the separation of the capital cost of construction from the running cost; and lack of motivation in cost optimisation. In the same vein, the difficulties associated with LCC on the part of the client includes; lack of understanding, and the presence of multiple aspects of needs desired by clients (Kishk & Al-Hajj, 1999). The difficulties on the part of the analyst include the difficulty in obtaining the proper level of information upon which to base LCC (Flanagan et al., 1989; Ferry & Flanagan, 1991; Kishk & Al-Hajj, 1999). Bull (1993) identifies lack of appropriate, relevant and reliable historical information and data as a major threat to the application of LCC technique by the analysts in the construction industry. Cost estimating methods are also identified as an obstacle to LCC technique. For instance, Mason & Kahn (1997) argue that cost estimating may be difficult at an early stage of the design, due to lack of data or insight. Sparks & McHugh (1984) assert that many companies use judgement in their predictions as they found statistical methods to be far more cumbersome, expensive, and no more accurate. Therefore, it can be deduced that LCC concept is difficult to apply in practice. While cost forecasting is not a new concept in construction, LCC presents a new set of challenges for the industry's costs experts (Hunter et al., 2005; Boussabaine, 2007).

2. RESEARCH METHOD

The target population for this study was professional quantity surveyors working for consultancy practices of varying sizes in the UK. The rationale for selecting only professional quantity surveyors was to achieve the research question of 'how the professional quantity surveyors view and use LCC'. Prior to data collection, the questionnaire was pre-tested. Thus, the questionnaire was electronically sent to three quantity surveyors consultancy firms with the purpose of testing and improving the questionnaire. This is supported by Fellows & Liu (2008) who assert that questionnaires should initially be piloted, i.e. completed by a small sample of respondents, before data collection. The feedback of pre-testing indicated that there was a potential difficulty in carrying out research into the application of LCC due to its wide range of possible

interpretations. In order to address this challenge, the definition of LCC was included in the cover email as 'a methodology for systematic economic evaluation of life-cycle costs (cost of an asset or its parts throughout its life cycle, while fulfilling the performance requirements) over a period of analysis, as defined in the agreed scope' (BSI, 2008). The participants of the study (i.e. professional quantity surveyors) were randomly selected from consultancy firms of varying sizes in the UK. The list from which the participants were randomly chosen allowed the inclusion of quantity surveyors of varied levels of experience, belonging to firms of varying sizes. Adopting random sampling technique eliminated possible bias (Perera et al., 2011). The data for this study were collected through questionnaire survey distributed electronically; this method of questionnaire administration has been adopted in prior construction management research (Swaffield & McDonald, 2008; Perera et al., 2011) among others. The designed questionnaire was a multiple-choice type questionnaire on a five-point Likert scale. The questionnaire was divided into two sections: the first section focused on background information, while the second section was structured in relating to professional quantity surveyors' disposition to LCC, barriers to LCC and factors responsible for their disposition to LCC. The questionnaire was administered to 50 randomly selected professional quantity surveyors working in consultancy firms of varying sizes in the UK. Out of 50 questionnaires administered, 34 (representing 68%) were returned and found appropriate for the analysis. The data collected for the study were analysed using descriptive and inferential statistics.

3. RESULTS AND ANALYSIS

Table 1 indicates that most of the respondents (50%) were from large organisations possessing more than 400 employees. 29.4% of the respondents were from organisations employing 150 employees or less, and 20.6% of respondents were from organisations with 151 to 400 employees. A considerable percentage of the respondents (47.1%) had 5yrs or less experience in the QS profession, 32.4% of the respondents had 6 to 10 years of experience, and 20.6% had more than 10yrs of experience. It can be safely assumed that the respondents had adequate experience to supply reliable data for this study. Table 1 further reveals that 32.4% of the respondents were directly involved in the use of LCC in their organisations while 67.6% of respondents were not directly involved in LCC. This indicates that not all construction organizations in the UK are using LCC application on construction work.

Table 1: Background information of respondents

Variables	Levels	Frequency	Percent
Size of organisation (approximate number of employees in UK)	150 employees or less	10	29.4
	151 to 400 employees	7	20.6
	More than 400 employees	17	50.0
	Total	34	100.0
Years of experience in the QS profession	5yrs or less	16	47.1
	6 to 10 yrs.	11	32.4
	More than 10 yrs.	7	20.6
	Total	34	100.0
Involvement in LCC exercise	Directly involved	11	32.4
	Not directly involved	23	67.6
	Total	34	100.0

Table 2: Barriers to greater use of LCC

Item	Barrier Freq.	May be Freq.	Not a barrier Freq.	Don't know Freq.	RSI	Rank
Lack of fiscal measures that encourage clients' use of LCC	27	6	1	0	0.941	1
Clients are unwilling to pay for LCC	23	10	1	0	0.912	2
Incompatibility with client's intangible or non-financial objectives and needs	18	12	3	1	0.846	3
Difficulty in obtaining the appropriate, relevant and reliable information and data	17	14	2	1	0.846	3
Clients do not request for LCC	20	7	3	4	0.816	5
Lack of procurement and contract award incentives to use LCC	15	15	2	2	0.816	5
Separation of capital/acquisition and running costs of most projects	17	10	5	2	0.809	7
The results are difficult to interpret and not directly useful	14	14	4	2	0.794	8
LCC skills are unavailable	19	5	6	4	0.787	9
There is insufficient time to carry it out	17	5	9	3	0.765	10
Lack of a standard method of life cycle costing	13	11	6	4	0.743	11

Table 3 reveals the categories of professional quantity surveyors' disposition to the use of LCC. It shows that 52.9% of professional quantity surveyors were indifferent to the use of LCC, 26.5% were unfavourably disposed to the use of LCC, and 20.6% were favourably disposed to the use of LCC in their various organisations. It can be deduced that there is a general lack of understanding of LCC principles among quantity surveyors because few public sector building clients in the UK are making decisions based on LCC. The lack of appreciation of LCC translates to reduced demand for LCC from construction clients except in PFI/PPP projects when LCC is mostly carried out at the early stage of procurement.

Table 3: Disposition of professional quantity surveyors to LCC

	Frequency	Percent
Unfavourably disposed to the use of LCC	9	26.5
Indifferent to the use of LCC	18	52.9
Favourably disposed to the use of LCC	7	20.6
Total	34	100.0

Table 4 indicates the ANOVA results, thus, ANOVA was used in determining and comparing the statistical significance among size of the organizations, proportion of projects in which LCC was used, and years of experience, on the quantity surveyors' disposition to LCC. The result of ANOVA indicates that size of the organization ($F(2,33) = 7.032$, $p < 0\ .05$) and the proportion of projects in which LCC was used ($F(3,33) = 3.254$, $p < 0.05$) had significant influence on professional quantity surveyors' disposition to LCC. While the years of experience of quantity surveyors ($F(2,33) = 0.128$, $p > 0.05$) has no significant influence on quantity surveyors' disposition towards the use of LCC. Thus, Posthoc test of multiple comparisons was conducted on the size of the organizations and the proportion of projects in which LCC was used, because both have significant influence on professional quantity surveyors' disposition to LCC and with a view to understanding the sources of the differences observed. The results are presented in Table 5 and 6 respectively.

Table 4: ANOVA result on factors responsible for professional quantity surveyors' disposition to LCC

Variables	Statistical comparison	Sum of Squares	df	Mean Square	F	Sig.
Size of the organisation	Between groups	57.386	2	28.693	7.032	0.003
	Within groups	126.497	31	4.081		
	Total	183.882	33			
Proportion of projects in which LCC was used	Between groups	45.146	3	15.049	3.254	0.035
	Within groups	138.737	30	4.625		
	Total	183.882	33			
Years of experience as a QS	Between groups	1.509	2	0.754	0.128	0.880
	Within groups	182.373	31	5.883		
	Total	183.882	33			

Table 5 reveals the result of Posthoc test of multiple comparisons carried out on the respondents' disposition on the basis of the size of the organisations. Table 5 indicates that the larger the size of the organisation, the better the disposition of the quantity surveyors. For instance, those in organisations with more than 400 employees had better disposition than those in organisations with 151 to 400 employees (mean difference = 2.78, $p < 0.05$) and also than those in organisations with 150 or fewer employees (mean difference = 2.45, $p < 0.05$). The differences in the disposition of QSs in organisations with 151 to 400 employees and those in organisations with 150 or less employees were not significant ($p > 0.05$). This test was also conducted for the proportion of projects in which LCC was used (see Table 6).

Table 5: Posthoc test of multiple comparison of professional quantity surveyors' disposition on the basis of size of organisations

(I) Size	(J) Size	Mean diff. (I-J)	Std. error	Sig.	95% conf'd interval Lower bound	Upper bound
150 employees or less	151 to 400 employees	0.32857	0.9954	0.942	-2.1215	2.7786
	More than 400 employees	-2.45294*	0.8050	0.013	-4.4343	-0.4716
151 to 400 employees	150 employees or less	-0.32857	0.9954	0.942	-2.7786	2.1215
	More than 400 employees	-2.78151*	0.9071	0.012	-5.0142	-0.5488
More than 400 employees	150 employees or less	2.45294*	0.8050	0.013	0.4716	4.4343
	151 to 400 employees	2.78151*	0.9071	0.012	0.5488	5.0142

*The mean difference is significant at the 0.05 level

Table 6 indicates the result of Posthoc test of multiple comparisons conducted on the respondents' disposition on the basis of the proportion of projects in which LCC was used. It shows that the mean difference in quantity surveyors' disposition to the use of LCC is significant when the proportion of projects in which LCC was used is 11 to 50% (mean difference = 3.64, $p < .05$) compared with mean differences for 6 to 10% and 5% or less; their mean differences were not significant ($p > 0.05$). It can be deduced that the larger the proportion of projects in which LCC was used, the better the disposition of the quantity surveyors (see Table 6 for details).

Table 6: Posthoc test of multiple comparison of professional quantity surveyors' disposition on the basis of the proportion of projects in which LCC was used

(I) Proportion Used	(J) Proportion Used	Mean diff. (I-J)	Std. error	Sig.	95% conf'd interval Lower bound	Upper bound
None	5% or less	-1.44444	0.93251	0.422	-3.9800	1.0912
	6 to 10%	-2.01587	1.08374	0.266	-4.9627	0.9309
	11 to 50%	-3.64444*	1.19948	0.024	-6.9060	-0.3829
5% or less	None	1.44444	0.93251	0.422	-1.0912	3.9800
	6 to 10%	-0.57143	1.00816	0.941	-3.3127	2.1699
	11 to 50%	-2.20000	1.13166	0.232	-5.2771	0.8771
6 to 10%	None	2.01587	1.08374	0.266	-0.9309	4.9627
	5% or less	0.57143	1.00816	0.941	-2.1699	3.3127
	11 to 50%	-1.62857	1.25919	0.574	-5.0524	1.7953
11 to 50%	None	3.64444*	1.19948	0.024	0.3829	6.9060
	5% or less	2.20000	1.13166	0.232	-0.8771	5.2771
	6 to 10%	1.62857	1.25919	0.574	-1.7953	5.0524

*The mean difference is significant at the 0.05 level

4. CONCLUSIONS

The study revealed low levels of direct involvement of professional quantity surveyors in the use of LCC application in consultancy firms of varying sizes in the UK. The study, therefore, identified prevalent barriers to greater use of LCC outside PFI/PPP context by professional quantity surveyors in consultancy firms. This includes: lack of fiscal measures that encourage clients' use of LCC; clients are unwilling to pay for LCC; incompatibility with client's intangible or non-financial objectives and needs; difficulty in obtaining the appropriate, relevant and reliable information and data; and clients do not request for LCC. The study found that there is a general lack of understanding of LCC principles among professional quantity surveyors because few public sector building clients in the UK are making decisions based on LCC outside PFI/PPP projects. The study further revealed that size of the organisations and the proportion of projects in which LCC was used had a significant influence on quantity surveyors' disposition

towards the use of LCC. The study through Posthoc test found that professional quantity surveyors in organisations with more than 400 employees had better disposition to LCC than those in organisations with 151 to 400 employees, and also than those in organisations with 150 or fewer employees. The Posthoc test result further revealed that professional quantity surveyors have better disposition to LCC when a larger proportion of projects use LCC (for example 11 to 50% of projects compared with 6 to 10% and 5% or less). The study concludes that the larger the size of organisations and the bigger the proportion of projects in which LCC was used, the better the disposition of the professional quantity surveyors to LCC. Therefore, the study recommends internal and external short courses on LCC principles and applications for professional quantity surveyors with a view to improving their understanding on LCC. Also, professional bodies such RICS, CIOB among others should sensitise the public clients in adopting LCC for construction works outside PFI/PPP context. The limitation of this study was the small sample size, as a larger number of respondents from questionnaire survey would have increased the credibility of the results. But the study findings are very useful and beneficial to all stakeholders in the construction industry, as value improvement in this sector is imperative. Also, LCC helps towards achieving economic sustainability. Therefore, knowledge of the factors influencing the professional quantity surveyors' disposition to LCC use will enlighten quantity surveyors, clients and other stakeholders in the construction industry. It will help quantity surveyors among others, to be trained in the practicalities of LCC, including how to use standardised LCC methods in construction organisations. Further studies need to be carried out on LCC perception among construction clients, besides the government and quasi-public clients.

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