BARRIERS TO LIFE CYCLE COSTING USAGE

Olufolahan Oduyemi[1], Michael Okoroh and Angela Dean

Faculty of Art, Design and Technology, School of Engineering & Technology, University of Derby, DE22 1GB, UK

Life Cycle Costing (LCC) is widely recognized amongst practitioners and academics as a valuable tool in assessing the economic efficiency of constructed facilities. Clients now want buildings that demonstrate value for money over a long term, and are not interested simply in the design solution which is the least expensive. This change have led to and highlighted the importance of LCC approaches to the design, construction and operation of buildings. However, the majority of building designs are still currently produced unsullied by thoughts of maintenance implications, life expectancy or energy consumption. In a forward looking approach, the paper attempts to provide some recommendations that should facilitate and enhance the implementation of LCC in the UK. A questionnaire was distributed to two group samples of 80 practitioners; the quantity surveyors and builders with a total of 70 practitioners (35 aside) completing the survey. The key findings of the statistical analysis indicated that builders ranked the lack of data as the most prevalent problem while quantity surveyors felt it was the lack of a universal framework. The results suggest that there are different opinions and perplexity on issues relating to LCC application. This research will be of interest to industry practitioners and academic researchers with an interest in life cycle costing

Keywords: barriers, life cycle costing, techniques.

INTRODUCTION

Several studies (Pelzeter, 2007; Olubodun *et al*. 2010; Opoku, 2013) have strongly advocated the need to consider the long-term cost of design decisions. Recent guidance for projects procured using the Private Finance Initiative (PFI) or Public-Private Partnership (PPP) routes advocates the use of life cycle costing techniques specifically as they provide an assessment of the long-term cost effectiveness of a project. It can be used as a means of comparing options and their associated costs over a period of time (Cuéllar and Azapagic, 2014) or as a tool for assessing the long terms costs of ownership in existing buildings through stochastic modelling and key performance indicators (Kirkham and Boussabaine, 2000a).

Given the capacity of LCC to capture essential information associated with the management of an organisation's assets and the enhancements in decision making competence which it offers, it is rather disappointing that these benefits are not replicated in reality where there is an obvious lack of attention paid to LCC (TRADA Technology, 2008).

Undeniably, numerous studies and in particular Olubodun *et al*. (2010) and Arja *et al*. (2009) all recognised a significant absence of LCC implementation in construction

[1] o.oduyemi@derby.ac.uk

Oduyemi, O, Okoroh, M and Dean, A (2014) Barriers to life cycle costing usage *In:* Raiden, A B and Aboagye-Nimo, E (Eds) *Procs 30th Annual ARCOM Conference*, 1-3 September 2014, Portsmouth, UK, Association of Researchers in Construction Management, 783-791.

operations. Subsequently, several researchers have sought to determine the barriers of life cycle costing methodology (Glucha and Baumannb, 2003; Kishk *et al*. 2005; Swaffield and McDonald, 2008). However, no research has simultaneously enquired about the views from Quantity Surveyors and Builders on the likely barriers of LCC application.

The advantages of using life cycle costs are undeniable. Bouachera, Kishk and Power (2007) in their research project concluded that it enables practitioners and researchers to evaluate long-term effects on different construction schemes. This paper therefore evaluates the barriers in LCC applications in the UK and suggests how the usages can be improved. It also discusses a survey with Quantity Surveyors and Builders, majority of who have worked in the construction industry for over 5 years.

DATA COLLECTION

A survey utilizing a questionnaire was distributed electronically by email to a random sample of 80 practitioners (Quantity Surveyors and Builders) in the UK. The questionnaire comprised three main sections (tables 1-3) each exploring different parts of the research question.

The first section sought information on the respondent's profile as shown in tables 1 and 2. The second section included questions primarily addressing the application of LCC as shown in (see table 3). The third section ranked 13 key challenges identified from the literature. The questionnaire responses were assigned numerical codes and the data was analysed using descriptive and inferential statistics methods in Stata version 12.0

ANALYSIS AND DISCUSSION OF RESULTS

Respondents' profiles

Table 1 show that 50% of the respondents are either Quantity Surveyors or Builders. And that 8 out of 35 Builders have between 8 out of 35 Builders have between 0-5 years construction experience, 19 have 6-10 years and 8 respondents with over 11 years' experience.

Table 1: Respondent's response rate and years of experience

Background	Freq	Percent	Cum	0-5	6-10	11 and above
Builders	35	50	50	8	19	8
QSY	35	50	100	14	7	14
Total	70	100		22	26	22

Table 2 below shows that all respondents had a degree in construction related courses while 16 builders and 17 quantity surveyors had a Post-graduate degree although none had a Doctor of Philosophy (PhD). Similarly, 54 professionals (25 builders and 29 QS) were members of the Royal Institution of Chartered Surveyors (RICS), 31 respondents (18 builders and 13 QS) were members of the British Institute of Facilities Management (BIFM) while 59 respondents (32 builders and 27 QS) were members of the Chartered Institute of Building (CIOB). This means that all respondents are suitable to proffer answers to the objectives of the study.

Table 2: Respondent's Academic and Professional Qualifications

Background	BSc		MSc		PhD		RICS		BIFM		CIOB		Total
	0	1	0	1	0	1	No	Yes	No	Yes	No	Yes	
Builders		35	16	19	35	-	10	25	17	18	3	32	35
QSY		35	17	18	35	-	6	29	22	13	8	27	35
Total		70	33	37	70		16	54	39	31	11	59	70

Application of LCC

Table 3 noted that all respondents were aware of LCC application. Most of them (34 builders and 33 QS) were directly involved in LCC application. 67 respondents (33 builders and 34 QS) have used LCC less than 20 times while 2 respondents (1 builder and 1 QSV) have used it between 21 and 40 times, no respondent has used LCC more than 40 times. This shows the limited understanding and restricted usage of LCC. This could be ascribed to the barriers associated with LCC implementation earlier mentioned in this paper.

Table 3: Application of LCC

Background	Often used			Total
	Less than 20	Btw 21 and 40	More than 40	
Builders	33	1	0	35
QSY	34	1	0	35
Total	67	2	0	70

Background	Direct use		Total
	No	Yes	
Builders	34	1	35
QSY	33	2	35
Total	3	67	70

Barriers to LCC

Lack of reliable data

In this survey, the builders stated that lack of readily available and reliable LCC data as the most significant barrier that inhibits the successful practical implementation of LCC (table 4). This factor is ranked second based on the Quantity Surveyors' opinions (table 5).This concurs with the findings by Swaffield and McDonald, (2008) on their research on LCC used by contractor's quantity surveyors on PFI projects and Pelzeter, (2007) who sought the views of real estate professionals on use of LCC in Germany and Sterner, (2000) on their surveys of stakeholders on LCC applications in the construction industry in Sweden.

Lack of common and standard method

Quantity Surveyors as shown on table 5 cited lack of a common method as the major limitation of LCC and one of the key problems that exist in LCC is the lack of an

acknowledged methodology for carrying out an LCC procedure. This factor is ranked second based on the builders' opinions (table 4). The journey towards a standardised method has been muted by practitioners since 1970. However, the construction industry is yet to develop a framework for LCC that is not only universally acceptable, but more importantly dynamic in use as most clients now want buildings that demonstrate value for money over a long term. Subsequently, several researchers have sought to use different methods to deliver effective solutions to the problems of uncertainty quantification (Kelly and Hunter, 2009; Kirkham, 2002; Choong, *et al*, 2002; Kirkham, Boussabaine and Kirkham, 2002). However, there is still no real credible user friendly method in place as the existing frameworks do not enable researchers to forecast future operational and maintenance costs before integrating quantitative risk assessment measures (Creedy, 2006).

Type of investor/user

Most developers are concerned with the initial costs as they do not manage the buildings when completed. This result in a lack of long-term interest in the building operating and maintenance costs and similarly, the lack of capital and the high financial costs and prevailing interest rates can limit investors on advanced investment to cut the operating costs.

Dealing with intangible factors

Dealing with intangible factors is also a very important barrier as the design or component selection decisions can often be taken based on factors other than financial criteria. Most of these factors cannot be assessed in a strict LCC framework. This is mainly because either they are in conflict with the main LCC objective or because they are mostly ‘non-financial’ (Kishk, Al-Hajj and Pollock, 2001).

Table 4: Builder's level of agreement

Variable	Obs	Mean	Std Dev	Min	Max
Lack of reliable data	35	4.686	0.900	1	5
Lack of common standard	35	3.571	1.170	2	5
Type of investor	35	3.686	1.762	1	5
Dealing with intangibles	35	3.286	1.426	1	5
Lack of procurement award incentives	35	2.714	1.226	1	4
Lack of monitoring	35	2.914	1.222	2	5
Risk and Uncertainty	35	2.486	1.380	1	5
Lack of clarity of LCC principles	35	2.914	1.442	1	5
Lack of fiscal encouragement	35	2.765	1.372	1	5
The industry’s relative lack of interest in LCC implications	35	2.171	1.150	1	5
Overabundance of cost models	35	2.229	1.060	1	4
Not required by Clients	35	1.800	0.933	1	4
Market Conditions and Assumptions	35	1.829	0.857	1	3

Market conditions

The prevalent market conditions have momentous influence on LCC. The future is unknown, but LCC encompasses a countless deal of forecasts and assumptions of the future. These include the maintenance and operating costs, rate of interests, inflation, material and component prices. But in truth, these factors tend to change when applied to different interest rates and different scales (Korpi and Ala-Risku, 2008). The uncertainty surrounding the variables used in any LCC model should be eliminated to improve the precision of the approximation.

Risk and uncertainty

It has been widely noted that concerns about using a LCC approach are based mainly on the risky nature of the assumptions on which the forecasts are modelled (Boussabaine and Kirkham, 2008). Whilst forecasting of future costs is to some extent not an inexact science, this should not dissuade analysts and managers from attempting to apply LCC principles (Kishk, Al-Hajj and Pollock, 2001).

Table 5: Quantity Surveyor's level of agreement

Variable	Obs	Mean	Std. Dev.	Min	Max
Lack of common standard	35	4.514	0.853	2	5
Lack of reliable data	35	4.743	0.443	4	5
Risk and uncertainty	35	3.971	1.175	1	5
Market conditions	35	1.800	1.132	1	5
Not required by clients	35	2.371	1.555	1	5
Dealing with intangibles	35	1.714	0.926	1	4
Type of user	35	2.371	1.190	1	5
Lack of fiscal encouragement	35	2.143	1.089	1	4
Lack of monitoring	35	2.629	1.395	1	5
Lack of procurement award incentives	35	2.914	1.442	1	5
Lack of clarity of LCC principles	35	3.114	1.451	1	5
The industry's relative lack of interest in LCC implications	35	3.029	1.485	1	5
Overabundance of cost models	35	2.143	1.216	1	5

Tables 6 to 9 show the Pearson's correlation that was applied to four random factors to determine if there was a significant difference in the opinions of the builders and quantity surveyors.

In the main majority of clients are ill informed about the benefits of a life cycle approach, which can lead to subjective decision-making. Moreover, clients may have

a limited foreseeable use for the building and different organisations may have different expectations of the constructed asset in the future. Therefore, it is critical to understand the expectations of different project participants throughout a project's life and consider the relevant factors which affect the implementation of LCC.

Table 6: Lack of reliable data

Background	Lacofreliabdata					Total
	1	2	3	4	5	
Builders	1	1	1	2	30	35
QSY	0	0	0	9	26	35
Total	1	1	1	11	56	70

Pearson chi2(4) = 7.7403 Pr = 0.102

This means that there is no significant difference in the opinion of either the builders or quantity surveyors

Table 7: Lack of common methodology

Background	Lacofcomonstd					Total
	1	2	3	4	5	
Builders	0	9	7	9	10	35
QSY	0	2	2	7	24	35
Total	0	11	9	16	34	70

Pearson chi2(3) = 13.2470
Pr=0.004

This means that there is no significant difference in the opinion of either the builders or quantity surveyors

Table 8: Risk and Uncertainty

RISK AND UNCERTAINTY

Background						Total
	1	2	3	4	5	
Builders	15	0	9	10	1	35
QSY	2	1	9	7	16	35
Total	17	1	18	17	17	70

Pearson chi2(4) = 24.7059
Pr=0.000

Note: p-value = 0.000 indicates that the opinion of the builders is significantly different from those of the quantity surveyors.

Table 9: Not required by clients

NOT REQUIRED BY CLIENTS (Notrequiclient)

Background	1	2	3	4	5	Total
Builders	17	10	6	2	0	35
QSY	15	7	5	1	7	35
Total	32	17	11	3	7	70

Pearson chi2(4) = 8.0787 Pr = 0.089

Note: At p-value = 0.089, this implies the difference in the opinion of both builders and quantity surveyors is significantly different only 10 percent significant level.

The results from the table 6 to 9 suggest that there are different opinions and perplexity on issues relating to LCC application. Whilst the survey of the barriers of LCC abound, this is the first time a survey of builders and quantity surveyors has been carried out. Builders were selected in particular as there has been an exponential increase in the number of developers and self-build in recent years and most especially with the rapid increase in energy efficient buildings.

The majority of barriers are directly associated to the lack of adequate knowledge of LCC processes and mechanisms. They may also be due to lack of readiness from stakeholders to set up suitable mechanisms to resolve these issues. These and other issues need to be adequately tackled before a higher level of application of LCC can be established.

RECOMMENDATIONS AND CONCLUSION

As discussed above, there are many obstacles facing the practical implementation of LCC. This presents an interesting challenge on exploring new approach that would seek to spread the benefits of LCC and overcome some of the above barriers to LCC adoption. In response, a number of remedial actions have been suggested such as the development of a standardised LCCapproach (British Standard Institute, 2008) and the introduction of more Building Cost Information Service (BCIS) cost data sets for life cycle cost analysis

These are also issues which could be addressed by a recognised organisation in the industry such as the RICS and the CIOB. These professional organisations could encourage increased LCC education for their members. It is also expedient to integrate risk and uncertainty in LCC calculations in order to improve the precision of forecasts. Failure to do this would result in not reaping the benefits of the LCC applications, as cost computations would be inexact. Applying these procedures and steps would augment the accuracy of cost forecasts, accelerating the integration into the examination of unanticipated happenings all through the life cycle of the building.

This paper has given an overview of the barriers of LCC application in the UK with suggestions on how its implementation can be improved. This has led to the identification of the most relevant barriers hindering its implementation. It also ranked the opinions of Quantity Surveyors and Builders. This would effectively allow

researchers to be more aware about the obstacles hindering the frequent application of LCC. It is hoped that as a consequence, the industry will make constructive strides towards application of LCC a as a mechanism for considering the cradle to grave implications of their work.

REFERENCES

Arja, M, Sauce, G and Souyri, B (2009) External uncertainty factors and LCC: a case study. *"Building Research & Information"*, **37**(3), 325-334.

Bouachera, T, Kishk, M and Power, L (2007) Towards A generic framework for whole life costing in the oil industry. In: Boyd, D (Ed.), *"23rd Annual ARCOM Conference"*, 3-5 September 2007, University of Belfast. Association of Researchers in Construction Management, 863-871.

Boussabaine, A and Kirkham, R (2008) *"Whole life-cycle costing: risk and risk responses"*. John Wiley & Sons.

British Standard Institute/British Cost Information Service (2008) *"Standardized method of life cycle costing for construction procurement"*, A supplement to BS EN ISO 15686-5 Building and constructed asset – Service life planning; Part 5 – Life Cycle Costing. United Kingdom: BSI/BCIS.

Choong, P M and Sharratt, P N (2002) A life-cycle framework to analyse business risk in process industry projects, "Journal of Cleaner Production", **10**(5), 479-493.

Creedy, G (2006) *"Client risk factors leading to cost over-run in highway projects"*. Client Driving Innovation: Moving ideas into practice.

Cuéllar-Franca, R M and Azapagic, A (2014) Life cycle cost analysis of the UK housing stock. *"The International Journal of Life Cycle Assessment"*, **19**(1), 174-193.

Glucha, P and Baumannb, H (2003) The life cycle costing (LCC) approach: a conceptual discussion of its usefulness for environmental decision-making, *"Building and Environment"*, **39**(2), 571-580.

Kelly, J and Hunter, K (2009) *"Life cycle costing sustainable design"*. United Kingdom: RICS Research.

Kirkham, R J (2002) *"A stochastic whole life cycle cost model for an NHS acute care hospital building"*, PhD thesis, The University of Liverpool, UK

Kirkham, R J and Boussabaine, A H (2000a) Developing a Framework for Whole Life Costing in the National Health Service Estate. *"Proceedings of the 16th Annual Conference of the Association of Researchers in Construction Management"*, Glasgow Caledonian University'.

Kirkham, R J, Boussabaine, A H and Kirkham, M P (2002) Stochastic time series forecasting of electricity costs in an NHS acute care hospital building, for use in whole life cycle costing. *"Engineering, Construction and Architectural Management"*, **9**(1), 38–52.

Kishk, M, Al-Hajj, A, Aouad, G and Pollock, R (2005) A practical cost break down structure for effective whole-life costing of built assets, *"2nd International SCRI Symposium"*, University of Salford.

Kishk, M, Al-Hajj, A and Pollock, R (2001) Inclusion of non-financial factors in life-cycle decisionmaking: a fuzzy approach. In: Akintoye, A (Ed.), *"17th Annual ARCOM Conference"*, 5-7 September 2001, University of Salford. Association of Researchers in Construction Management, **1**, 411-20.

Korpi, E and Ala-Risku, T (2008) Life cycle costing: a review of published case studies. *"Managerial Auditing Journal"*, **23**(3), 240-261.

Olubodun, F, Kangwa, J, Oladapo, A and Thompson, J (2010) An appraisal of the level of application of life cycle costing within the construction industry in the UK. *"Structural Survey"*, **28**(4), 254-265.

Opoku, A (2013) The Application of Whole Life Costing in the UK Construction Industry: Benefits and Barriers. *"International Journal of Architecture, Engineering and Construction"*, **2**(1), 35-42.

Pelzeter, A (2007) Building optimisation with lifecycle costs- the influence of calculation methods. *"Journal of Facilities Management"*, **5**(20), 115-128

Sterner, E (2000) Life-cycle costing and its use in the Swedish building sector, *"Building Research & Information"*, **28**(5), 387-93.

Swaffield, A and McDonald, M (2008) The contractor's use of life cycle costing on PFI projects, *"Engineering, Construction and Architectural Management"*, **15**(2), 132 – 148

TRADA TECHOLOGY, (2008) Life Cycle Costing. *"Wood Information Sheet"* **4**(31).