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The Practice of Life Cycle Cost in Malaysia Construction Industry: A Review

Wan Nur Hamizah Wan Hassan, Norhanim Zakaria,
Muhammad Azzam Ismail
Department of Quantity Surveying,
Faculty of Built Environment, University of Malaya
gurlmyzah@gmail.com

ABSTRACT

Life cycle cost (LCC) is a concept and practices that seem ambiguously understood in the construction industry in Malaysia. This paper reports on the initial phase of the study and its results. The initial study was carried out through the literature review on LCC in general and focuses on the application of LCC in Malaysia. The main focus on this study is to identify the current practice and the enhancement of the LCC in construction projects. There are six (6) practitioners in construction industry that been interviewed in related to the research study. The outcome of this research shows that most of the practitioners are aware on the term and concepts of the LCC but did not apply in their construction projects. There are few challenges are listed and their opinions on the solution to solve the lack of application LCC. The paper also identifies the elements cost and evaluation method used in developing the LCC plan.

Keywords: *Construction Industry, Life Cycle Costing, Maintenance*

INTRODUCTION

Life cycle cost was originally introduced in the mid-1990s in United States for procurement all types and purchases for the Department of Defense (Raymond J. Cole & Sterner, 2000). It involves the systematic consideration of all related cost and revenues connected with the ownership and acquisition of an asset (Gluch & Baumann, 2003; Raymond J. Cole & Sterner, 2000).

Not until much later, life cycle cost started to be used in United Kingdom (UK). The definition of this term is the costs involving the operating and purchasing of an asset. It is also known as ultimate cost, whole life costing or total cost analysis (Ashworth & Hogg, 2000).

In Malaysia, life cycle cost concepts and practices are seemed to be unrecognised and lack of knowledge for the practitioners in the construction industry (Noor Azizah & Zainal Abidin, 2012). Previous research stated that techniques for life cycle cost were seldom applied even though most developers and consultants aware of the terms and practice of it (Mazlan, 2010; Mohamed, Karim, Nor, & Kho, 2007). They only concentrate on the initial cost but very seldom take into consideration the future cost for example operation, maintenance, replacement when they proposed the development or building facilities (Mohd Fairullazi & Khairuddin Abdul, 2011).

Moreover, life cycle cost was applied to facilitate the agencies to identify the unnecessary cost, maximizing the cost saving in the building and optimise the overall life cycle cost to obtain the standard qualities demanded. Life cycle cost is implemented in value management in Malaysia introduced by University Teknologi Malaysia as a common technique for choosing the most cost effectiveness among the alternatives for the purpose of quality, cost saving, profitability and other criteria to meet the client requirements (Mat, 2010). According to Mohd Fairullazi (2012), there is no evidence found in the literature to support large number of people had knowledge on the life cycle cost did practiced the LCC techniques to evaluate total ownership cost of the building project in Malaysia construction industry.

LIFE CYCLE COST

Definition of Life Cycle Cost

Generally, life cycle cost is known as a valuable approach to compare the building designs alternative that enhance the operational cost benefits to be evaluated against any increasing initial cost (Raymond J. Cole & Sterner, 2000). Historically, life cycle cost is described by construction and building standard ISO15686 as a method which allows comparative cost assessments

to be created over certain period of time, taking into consideration all economic aspects both capital costs and future maintenance and operation cost (Gluch & Baumann, 2003).

The basic idea of the construction project life cycle cost management is developed from the traditional process of cost management in deficiencies and defects. The overall cost of project management usually concentrate in the construction project cost, while ignoring the costs operations, maintenance costs and the cost of the abandoned project at the end of project life (Li, Zhu, & Zhu, 2012). Generally, the production cost is the main cost factor in construction and often set to the minimum, which does not important in improving the lifetime performance of buildings. However, a higher production cost might reduce the total life cycle cost (CABA, 2004; Levander, Schade, & Stehn, 2007).

According to Li and Zhu (2012), once the project put into use, the operating and maintenance cost is greater than the project's construction cost usually in 5-10 times. In the life cycle cost theory, the project economic evaluation will be taken into consideration the whole life period of the construction costs, using operating, maintenance costs and wasting cost. These will lead to choose the best investment method, to enhance the good quality of project and achieve minimum of cost target and to achieve the most economical in the project construction (Li et al., 2012).

Section 707 of Executive Order 13123 defines life cycle cost as "... the sum of present values of investment costs, capital costs, energy costs, operating costs, maintenance costs, and disposal costs over life-time of the project, product or measure." Flanagan and Jewell (2005) define the LCC as an exercise that is carried out to evaluate the effectiveness of many different solutions in order to determine the best option.

Fuller (2005) identifies the LCC analysis is an economic method of project evaluation in which all costs arising from owning, operating, maintaining, and disposing of a project are considered important to a decision. The LCC method takes into consideration the initial costs which are capital investment costs, purchase, installation cost, capital replacement costs, financing costs and any resale or disposal cost over the lifetime of the project, product or measure (Flanagan & Jewell, 2005; Fuller, 2005; Li et al., 2012).

The economic evaluation which is known as life cycle cost has become the framework for measurement by the researchers in the past two decades (Flanagan & Jewell, 2005; John R Kelly, 2009; Kishk et al., 2003). Owner, occupants and organisation have common interest in improving the lifetime quality and cost effectiveness of buildings. There are several terms used such as "cost in use", "life cycle cost", "whole life costing" and "whole life appraisal". According to Flanagan and Jewell (2005), the terminology has changed over the years from "cost in use" to "life cycle costing" and further to "whole life appraisal". ISO Standard 15686 (2005) makes a difference between the "whole life costing" and "life cycle cost" which is the whole life costing covering wide range of analysis that include external cost and future cost of a building (Korytarova & Hromadka, 2010). Although the terms used are interchangeably, the life cycle cost is used equivalent to whole life costing/appraisal and the term life cycle cost is better known term used in the practice today (Levander et al., 2007; Mohd Fairullazi & Khairuddin Abdul, 2011).

Flanagan & Jewell (2005) and Ayob & Rashid (2011) stated that the older resources might refer the term as cost in use, changing over the year to the life cycle cost and further to whole life costing / appraisal for better represent concept. Different terms are actually interchangeably among them. Table 1 shows the definitions of life cycle cost by the organisations and researchers.

Table 1 : The Definitions of the Life Cycle Cost According to the Organization and Researchers

Organisations / Researchers	Definitions of Life Cycle Cost (LCC)
Section 707 of Executive Order 13123	Life cycle cost is the total of present values of capital costs, investment costs, energy costs, installation costs, operation cost, maintenance costs, and disposal costs over the life time of product or project.
Australian government document (Treasury, 2000)	Life cycle cost is the sum of cost during its life time with design, planning, support and acquisition costs and any other costs directly to having the project.

Royal Institution of Chartered Surveyors (2001)	Life cycle cost of an asset over its operating life which is the initial capital cost, occupation costs, operating costs, maintenance costs and the benefit of the refurbishment or disposal of the asset at the end of its life.
(El-Haram, Marenjak, & Horner, 2002)	Life cycle cost is a technique for identifying and evaluating all the costs in money terms direct and indirect including designing, building and facility management of a building throughout its service life with the disposal or refurbishment cost.
(Sirin, 2007)	Life cycle cost is the method of identifying and documenting the initial cost and external future cost of the development project during the lifetime of the building.

Economics Evaluation Method

Life cycle cost is an economic method to evaluate the life cycle cost effectiveness in which all costs form arising, operating, maintaining and disposing of a project in order to determine the best decision. There are many types of method that used in the calculations of life cycle cost depend on the data available. Some of the economic evaluation methods are shown in Table 2. Most of the researchers are agreed that the net present value (NPV) method is the mostly common method used in the analysis of life cycle cost.

Table 2 : The Economic Evaluation Methods

Economic Evaluation Methods	Descriptions	Advantages	Disadvantages
Simple Payback	• The number of years required to return the initial investment cost (1,2,3) • The shortest pay-back time is the most profitable investment (1) • Used in rough estimation or only as the screening tools (1,2)	• Quick and easy calculation • Easy to interpret	• Does not use discounted cash flows thus, ignores the time value of money (2) • Does not take into inflation or interest (1)

Economic Evaluation Methods	Descriptions	Advantages	Disadvantages
Net Present Value (NPV)	• Traditional method specific to the net present value of the investment from the present value of the benefit project (9) • Present value of cash flows minus the present value of cost (3) • If the result of NPV is positive, so it is useful to invest (4,5,6) • Most commonly techniques used in the construction industry (1,7,8,9)	• Use the time value of money into account (1) • Uses all available data (1,7)	• Not suitable if comparing the alternatives which have different life lengths (1) • Difficult to interpret (1,7)
Internal Rate of Return (IRR)	• Discount rate that makes the estimated NPV of an investment equal to zero • Compare the profitability of investment (4) • To determine the average rate return to the condition that the values equal to zero at the initial point of time (5,10) • Highest IRR is the best option (5,10)	• Results are presented in percent form which is easy to interpret (1)	• Need trial and error procedure (1)

Notes:
1. (Flanagan & Jewell, 2005)
2. (Fuller, 2005)
3. (Davis Langdon, 2005)
4. (Buys, Bendewald, & Tupper, 2011)
5. (Levander et al., 2007)
6. (Noor & Eves, 2010)
7. (Kishk et al., 2003)
8. (Noor Azizah & Zainal Abidin, 2012)
9. (Wong, Li, & Wang, 2005)
10. (ISO/DIS, 2004)

Life Cycle Cost Application

Life cycle cost is able to assist in the effective management completed buildings and projects also being able to select the choice between alternatives. Rum and Akasah (2012) propose the integrated life cycle design as the method that integrates the design, construction, maintenance, management, and operation of buildings into the comprehensive life time engineering. The life cycle cost can be implementing in various areas such as in the intelligent building, sustainable building, facility management, value management and others.

(a) Life Cycle Cost in the Sustainable Building

Sustainable building is known as a building that is planned, constructed and effectively managed by the occupants where the service life of building preserves the environment, ecological performance requirement, able to meet the capabilities and needs of future generation (Siti Hamisah, Fathoni, & Jamaludin, 2005). The advantages of a sustainable building are increasing energy saving, usage of recycled materials and reduced the emission of toxic substances (Mohd Fairullazi & Khairuddin Abdul, 2011). Even though the progress of the sustainable building is widely explored and it's essential to balance total economic cost, ecological performance and social life in Malaysia, there is no standard technique has been formulated to calculate the life cycle cost of a sustainable building.

(b) Life Cycle Cost in the Value Management

Value Management analysis used the life cycle cost as the common technique to the lowest cost among the options for the purpose of eliminating the unnecessary cost (Mat, 2010; Mazlan, 2010). The other performance criteria to meet the client's requirements also are evaluated through value management process such as quality, safety, reliability, fitness for purpose, maintainability, aesthetics, technology and increasing the cost savings (Abdul Lateef A & Olanrewaju, 2013).

(c) Life Cycle Cost in the Facility Management

The application of life cycle cost in the facility management is still new in Malaysia. According to the Tenth Malaysia Plan (2011-2015), the government encourages life cycle cost technique to become as a part of development culture in maintaining and preserving the asset in holistic manner and efficient (Mohd Fairullazi & Khairuddin Abdul, 2011).

(d) Life Cycle Cost in the Public Private Partnership Programme

Public Private Partnership (PPP) is a new procurement approach in Malaysia that refers to a working relationship between government and private organisation. The aim of this programme is to achieve the common goal in the public infrastructure and services (Mohd Fairullazi & Khairuddin Abdul, 2011). PPP programme concentrates on the life cycle cost, private sector innovation, service approach, and management skills for the long-term relationship between public and private division to gain value of money. However, this programme is still new in Malaysia and the implementation of life cycle cost is still limited.

OPERATION AND MAINTENANCE

According to BS 3811, maintenance is defined as the combinations of all technical and related administrative actions intended to retain an item in or restore it to a state in which it can perform a building in its original state so that it continues to reserve its function and purpose in life cycle of a building (Oh, 2006).

Operating and maintaining a building takes the biggest portion in the life cycle cost of a building (Mahdjoubi, Ahmed, & Anumba, 2004). Maintenance deals with the certain procedures, specific tasks, instructions, equipment, qualifications and resources required to control the sustainability within a specific use environment. Operation costs are used to keep track of such item as fuel, water and utility to operate the facility. The key factor is to find an optimal level of maintenance services in order to be consistent with the organisations objective of attaining minimum total cost (Oh, 2006).

Yoong (2006) stated that major expenditures on repairs is usually caused by unforeseen failure of detailing, faulty material or bad workmanship, compared by predicted overall ageing and so is almost impossible to forecast. Various variable factors contribute to the real cost of maintenance work making it very difficult to assess with the accuracy (Mahdjoubi et al., 2004).

RESEARCH METHODOLOGY

In According to Kumar (2005), literature review is one of the crucial preliminary tasks when carry out a research study. Apart of that, literature review also important to assist researcher to understand on how findings of the research fit into existing body of knowledge (Ranjit, 2005).One method of collecting data is to interview targeted respondents to gain information on the matters of interest (Uma, 2003). The purpose of conducting personal interview is to support and clarify uncertain findings from the survey (Goo, 2009). The process of validation of data ensures the credibility of the data that obtained from the case studies.

The interviews are involved the individual that have the expertise in the construction projects. There are six face-to-face interviews conducted with experience construction practitioners. There are a project manager and a director from two developer companies, a director from consultant firm, a director and two engineers from three contractor firms.

RESULTS AND DISCUSSION

All of the interviewees are given the same question related to the research study. Table 3 shows the details of the interviewees with their position, working experience and area of expertise.

Table 3: The Details of Interviewees

No	Position	Working Experience	Area of Expertise
A	Director	>20 years	Developer
B	Senior Project Executive	>20 years	Contractor
C	Director	>20 years	Consultant
D	Project Manager	11-15 years	Contractor
E	Project Manager	11-15 years	Developer
F	Senior Project Executive	6-10 years	Contractor

The interviews are focused on the knowledge, application and challenges of the life cycle cost in Malaysia construction industry. The findings that emerge from the interview were as follows:

(a) Knowledge and awareness on the life cycle cost

All of the interviewees are aware the importance of the life cycle cost to the construction. Some of them understand the definition and concept of the LCC but did not apply in their construction projects. They agreed that LCC can be implemented in various stages and become the most economic solution for project's whole life.

"....generally we know about the meaning and concepts of the life cycle cost"
Respondent A, B, C, D, E, F

"...we know that there are many phases to apply the life cycle cost in the construction projects such as at inception, design stage, construction and building in-use"
Respondent B, D, E, F

"...the life cycle cost highlights the economic evaluation in terms of value and time to achieve the required budget allocation"
Respondent A, C

(b) Elements cost for the development of life cycle cost

There was a common agreement in the elements cost used in the life cycle cost plan. Some of them added that the LCC is calculated with different cost depend on the stage of the project development.

> *"...there is important cost in developing the life cycle cost plan which are the initial cost, construction cost, maintenance and operation cost"*
> *Respondent A, B, C, D, E, F*
>
> *"...development cost is important in the calculation of the LCC for the projects in the inception stage"*
> *Respondent B, D, E*
>
> *"...various stage of project development lead to the usage of different elements cost"*
> *Respondent F*

(c) Most known and used evaluation method

There were variable opinions on the familiarisation of evaluation method between the respondents. But most of them agreed that net present value is the most known method in the calculation of life cycle cost.

> *"...net present value method is the most known and used in the calculation of LCC"*
> *Respondent A, B, C, D, E, F*
>
> *"...internal rate of return and simple payback are sometimes applied in their construction projects"*
> *Respondent D, E*

(d) Challenges of the application LCC in construction projects

There was a variable dissatisfaction over the application of LCC in Malaysia construction projects.

> *"...clearly understand the concepts of LCC but did not apply in the construction projects"*
> *Respondent A, B, C, F*
>
> *"...poor demand from the construction clients in performing life cycle cost"*
> *Respondent C, D, E*
>
> *"...most Malaysian developers have 'sell' mentality therefore the life cycle of a building is not in their development policy in the first place"*
> *Respondent B*

(e) Mitigation the problems in application of LCC

There was a general opinion on the solution to solve the problems related to the LCC application in construction projects.

> *"...government should play an important role in the management policy or strategy to include the LCC in every construction projects"*
> *Respondent A, B, C, D, E, F*
>
> *"...practical courses or learning on the importance of LCC to the construction clients"*
> *Respondent C, D, E*
>
> *"...difficult to identify, examine and respond on the changing cost during the whole process of construction project"*
> *Respondent D, E, F*

CONCLUSION

As such, this study briefly describes the application of LCC among the practitioners in construction industry. Most of them aware in the terms and concepts of LCC but did not apply in their construction project because of the certain problems and circumstances. Findings from this research proved that the application of LCC in construction projects is still lack and limited. The net present value is used as main evaluation method to perform the LCC. The maintenance cost of the building is one of the important elements in calculating the LCC. As a conclusion, LCC is significant to the current Malaysia construction industry as obtaining value for money. It is an economic concept of time and value of money to compare the cost that will be spent over number of years. From the application of LCC, the efficiency as well as productivity can be maximised while the maintenance cost may be minimised.

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