IMPLEMENTING LIFE CYCLE COSTING IN MALAYSIA CONSTRUCTION INDUSTRY: A REVIEW

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ABSTRACT: Globally, the construction industry is one sector that contributes to economic growth in Malaysia. The construction industry is developing rapidly and become one of the backbones of the country compared with other developing countries in the world. As developing countries are now moving towards sustainable development is in line with the 9th Malaysia Plan, development should be built to meet current and future needs for achieving sustainability of economic development, social and environmental responsibility for the prosperity without compromising the needs of future generations. Therefore, to ensure the government's objective was achieved construction industry must implement the Life Cycle Costing (LCC) method to construct the structures and infrastructure projects that it will not cause losses to the industry itself and government. Each stage of construction project begins with planning, design, construction, operation, maintenance and demolishes the project and it cost should be considered to ensure the overall project costs as are known. Through this LCC, factors and maintenance costs for a building products accounted at the design stage to obtain a more accurate projection of the cost. This paper will describe the LCC as a vital element in all sectors of the construction industry because this method can drive quality improvement by taking into account the cost of a comprehensive project. The aim of this paper is to understand the LCC for the construction industry in Malaysia especially in maintenance phase. Secondly is to identify the process of LCC in buildings construction and last but not least is recommending that appropriate measures to implement the LCC in the construction industry in Malaysia. The main sources of the literature research will be taken through articles, journals, references books in the resources centre and internet search. Hopefully the implementation of LCC in the construction industry in Malaysia could be accessed and used for research reference by future researcher and as reference materials for the construction management industry in Malaysia.

Keywords: construction industry, life cycle costing, implementation, maintenance

1. INTRODUCTION

Construction industry is one sector that contributes to economic growth (CIMP, 2007). This industry is regarded as a stimulus to the development of other industries in introduced Malaysia as a developing country in the developed world. As the economy improved the construction industry will follow the same increase and at the same time demand will increase in economic construction. It is closely linked to the development of other sectors such as manufacturing, services, and etc. However, production of the construction sector is different from other sectors, it is not homogenous and each of it is considered unique and has its own value. The output of construction or design that is required must been meet the external influences which include sociology, politics, culture and economy (Aminah & Ismail, 2007).

According to the Economic Report 2010/2011, Ministry of Finance Malaysia (2010), development of construction industry was largely supported by the increase in civil engineering and non-residential property immediately following the implementation of development projects under the Ninth Malaysia Plan (9MP) and stimulus packages. The industry is estimated to grow 4.9 percent in 2010. Consistent with this report indirectly any infrastructure construction projects and commercial building ever built with the progress and success achieved by the country.

As a developing country, the construction industry in Malaysia is the most important and consistent where it involves a very detailed management on various matters such as management of
construction materials, machinery, technology, labour, implementation and etc, so well that it can realize its aspirations as well as fulfilling people’s basic needs. This industry is important because it is like as a tool of economic management for government as the Gross Domestic Product First Quarter of 2010 (GDP) highlight that the growth momentum to continue in the construction sector this quarter with record growth of 8.7 percent which includes Sub-Civil and Non-Residential which is a major contributor to this strong economic growth.

However the more sophisticated approach is needed for the design and construction of building facilities that through a combination of economic theory and computer technology where it is seen in terms of cost to design and build (Dhillon, 1989, Kirk & Dell’Isola, 1995; Hyo 2008). Nevertheless, owners can expand their perspective to include the cost of the operation, maintenance, repair, replacement, and disposal (Sirin, 2007; Venkataraman & Pinto, 2008). Therefore, to ensure the government’s objective was achieved construction industry must implement the Life Cycle Costing (LCC) method to construct the structures and infrastructure projects that it will not cause losses to the industry itself and government. LCC is the process of identifying and documenting the initial cost and total cost of the future on the development and operation of buildings during the lifetime of the building (Sirin, 2007, Bahr & Lennerts, 2008; Ade Asmi, 2009). Through this LCC, factors and maintenance costs for a building products accounted at the design stage to obtain a more accurate projection of the cost.

2. LIFE CYCLE COSTING

2.1 LIFE CYCLE COST DEFINITION

There are different terms used in the literature today like, cost in use, life cycle costs (LCC), whole life costing (WLC) and whole life appraisal (WLA). Where defined that the terminology has changed over the years from cost in use to life cycle costing and further to whole life costing (Flanagan & Jewel, 2005). They defined the new term whole life appraisal which is the systematic consideration of all relevant costs, revenues and performance associated with the acquisition and ownership of an asset over its physical / economic / functional / service / design life. It minimises total expenditure through proper appraisal of coats that will be incurred through the life facility.

LCC is a valuable technique that is used for predicting and assessing the cost performance of constructed assets. LCC is one form of analysis for determining whether a project meets the client's performance requirements (BS ISO: 15686-5, 2008). The Norwegian Standard defined LCC as including both original costs and cost incurred throughout the whole functional lifetime including demolition (NS 3454, 2000).

However, LCC also a process to determine the sum of all the costs associated with an asset or part there of, including acquisition, installation, operation, maintenance, refurbishment and disposal costs. It is pivotal to the asset management process as an input to the evaluation of alternatives via Economic Appraisal, Financial Appraisal, Value Management, Risk Management and Demand Management. LCC adds all the costs of alternatives over their life period and enables an evaluation on a common basis for the period of interest. This enables decisions on acquisition, maintenance, refurbishment or disposal to be made in the light of full cost implications (TAM, 2004).

According to Olanrewaju, Khamidi, Idrus and Shobowale (2010), the large sums of money are required to keep the facility in operations and in good conditions. Generally, in some cases running cost could be as high as 40% of the capital cost or even more. Anecdotal evidences have suggested that only about 10% of the total cost is actually required to complete the project. What this mean is nearly, 90% of the total cost of project is claimed by maintenance and running costs. The effects of the maintenance and running costs on the construction are so evident that any attempt to overlook them would be at the detriment of the client and in fact, to the professional competence of the designs’ and construction teams. Figure 1 show the LCC planning at different stages during a building lifespan.
2.2  **LCC MODEL**

According to Total Asset Management (2004), LCC model is an accounting structure containing terms and factors which enable estimation of an asset's component costs. A number of commercially available models can be used for LCC analysis. However, in some cases it may be appropriate to develop a model for a specific application. In either case, the LCC model should:

- Represent the characteristics of the asset being analysed including its intended use environment, maintenance concept, operating and maintenance support scenarios and any constraints or limitations;
- Be comprehensive enough to include and highlight the factors relevant to the asset LCC;
- Be easily understood to allow timely decision-making, future updates and modification; and
- Provide for the evaluation of specific LCC elements independently of other elements.

Before selecting a model, the purpose of the analysis and the information it requires should be identified. The model should also be reviewed with respect to the applicability of all cost factors, empirical relationships, constants, elements and variables. Refer figure 2 below to know the process of LCC fundamentally involves:

- Assessing costs arising from an asset over its life cycle; and
- Evaluating alternatives that have an impact on this cost of ownership.

An asset can be any item that has a value to an organisation over time. Items such as buildings, physical plant and equipment and computer software are normally regarded as assets. Consideration of all these costs is important, even if they are funded from different sources within an organisation (Better Practice Guide, 2001).

One may describe LCC models as predictive in nature and characterize a stochastic process involving many parameters such as interest rates and reliability. Nevertheless, irrespective of the types of models used for LCC analysis they all must be visible, transparent and effective in representing systems, equipment, subsystems or devices (Dhillon, 2009).
2.3 LCC METHOD

Cost estimating is a popular activity as various kinds of costs have to be estimated each day. The estimated cost has to be as close as possible to its actual value; otherwise it may lead to a consequence of a severe degree. Most specially, the success or failure of an organization may depend on the quality of cost estimates however over the years, people working in cost estimating area have to come up with several different cost estimation methods, models and procedures (Dhillon, 2009).

The literature shows that the most suitable approach for LCC in the construction industry is the net present value (NPV) method. Existing mathematical LCC models, which are based on NPV, have various advantages and disadvantages, as they differ in the breakdown costs elements. The model from the American Society for Testing Materials as shown in Eq.(1) for example, distinguishes between energy and other running cost, which is useful in adopting different discount rates for different cost items.

\[ \text{NPV} = C + R - S + A + M + E \]  

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\[ C = \text{investment costs} \]

\[ R = \text{replacement costs} \]

\[ S = \text{the resale value at the end of study period} \]

\[ A = \text{annually recurring operating, maintenance and repair costs (except energy costs)} \]

\[ M = \text{non-annually recurring operating, maintenance and repair cost (except energy costs)} \]

\[ E = \text{energy costs} \]

According to Arja, Souce & Souyri (2009), LCC can be calculated at any phase of the building life in assessing the overall cost of the buildings which are under construction or already in service. There are basically few steps to go in LCC (Barringer, 2003), as shown below:

1. Identify what has to be analyzed and the time period for the project life study along with the appropriate financial criteria.

2. Focus on the technical features by way of the economic consequences to look for alternative solutions.
3. Develop the cost details by year considering memory joggers for cost structures.
4. Select the appropriate cost model, simple discrete, simple with some variability for repairs and replacements, complex with random variations, etc.
5. Acquire the cost details.
6. Assemble the yearly cost profiles.
7. For key issues prepare breakeven charts to simplify the details into time and money.
8. Sort the big cost items into a Pareto distribution to consider further study.
9. Test alternatives for high cost items such as what happens if maintenance cost is up to 10% than planned, etc.
10. Study uncertainty/risks or/alternatives for high cost items as a sanity check and provide feedback to the LCC studies in iterative fashion.
11. Select the preferred course of action and plan to defend the decisions with graphics.

2.4 INTEGRATED LIFE CYCLE DESIGN

Integrated life cycle design is still at a phase of rapid development, and this is the start of the final formulation of a new integrated design process and methodology, which in future will serve as general design culture. The step will be in integration of the design, management and maintenance planning of buildings and civil infrastructures into comprehensive life time engineering (Asko, 2002). The main aspects included in the model are displayed in figure 3. The model might be able to address several facets of uncertainties, going beyond a traditional LCC model.

![Integrated life cycle design diagram]

Figure 3. Integrated life cycle design (Erika, Jutta & Lars, 2007)

3. OPERATIONS AND MAINTENANCE

Maintenance means any activity or combination of actions that cover the technical aspects and management function undertaken to maintain, preserve or recover a thing to the original condition. It is also a combination of any action taken to repair or relocate the things or tools appropriate to the situation acceptable (Wood, 2009). However, it also the work other than daily and routine cleaning, necessary to maintain the performance of the building fabric and its services (BS: 8210,1986).

Maintenance also is the one of the most difficult decisions facing facility/asset owners is the timing of different types of maintenance work in order to keep facilities up to a proper and acceptable state of repair. Several policies are available, ranging from a short-term temporary repair to the undertaking of a full-scale renewal. The choice of action depends on a number of factors and as a result significant reductions in maintenance costs are likely to result from a life cycle approach:

a. The cost of different types of repair.
b. The rate of deterioration.

c. The relationship between the physical life of the repair and required physical, functional and economic life of the facility.

d. The disruption and disturbance to the building occupants and time required for the repair.

Maintenance repair consists of three stages: inspection, diagnosis and constructional or remedial action. The maintenance can be classified under the following subheading (Flanagan & Jewel, 2005).

*Maintenance of the Main Structure:* The main structure is exposed primarily to the natural elements and maintenance work will probably involve inspection and routine planned maintenance.

*Maintenance of the Finishing/Fixture/Fittings:* The finishing suffers from wear and tear by the occupants and will require periodic renewal.

*Maintenance of the External Works:* The external works will require extensive maintenance with grass cutting, replacement of shrubs and trees and paving.

*Maintenance of the Plumbing, Mechanical and Electrical Services:* Each of the services elements will have its own maintenance requirements. While planned and preventive works will be undertaken, frequent corrective maintenance dependent upon the age will be needed.

*Modernisation and Adaptation:* This will often take place on a planned basis at a certain point in the facility life.

*Redecorations:* Internal and external redecorations will be necessary on a planned basis.

4. **RESEARCH AIDS**

The aim of this paper is to understand the LCC for the construction industry in Malaysia especially in maintenance phase. Secondly is to identify the process of LCC in buildings construction and last but not least is recommending that appropriate measures to implement the LCC in the construction industry in Malaysia. Those objectives will show the important of the implementation of LCC in construction industry especially during in operation and maintenance phase.

5. **SCOPE OF STUDY**

The scope of this study is limited to the government building in Malaysia such as Institution building like several building in Universiti Tun Hussein Onn Malaysia (UTHM), Johor. The scope is chosen based on the higher cost for energy consumption in institutions of the industrial sector. Institutions are also a place for convenience in order to produce excellent and quality students.

6. **RESEARCH METHODOLOGY**

Among the approaches used is through searching the source of printed materials and electronic media to facilitate the study of literature carried out while the questionnaires, interviews and brief discussion with the supervisor, certain person and respondents also facilitate the empirical study. To obtain accurate information and detailed the methods of this study will be implemented gradually based on figure 4 below:
6.1 RESEARCH POPULATION/SAMPLE
In this study, a questionnaire will be asked to certain people such as the occupant of the building, contractors, developer and building consultant to obtain statistically useful information about a given topic. It is the only feasible way to reach a number of reviewers large enough to allow statistically analysis of the results.

6.2 PROPOSED DATA COLLECTION METHOD
The interviews will be conducted with the questionnaire and also site survey to obtain detailed investigation information and data in maintenance problem and also to implement the life cycle cost approach to control the costing of the building during their life time.

6.3 Data analysis
This study data for questionnaire will be analysed by using Statistical Package for Social Sciences (SPSS) and Microsoft Excel to calculate the costing with information from interview and site survey will be discussed for more detailed result.

7. EXPECTED OUTCOMES
Hopefully at the end of this research will answer the objectives of this study which are to understand the LCC for the construction industry in Malaysia especially in maintenance phase. Secondly is to identify the process of LCC in buildings construction and last but not least is recommending that appropriate measures to implement the LCC in the construction industry in Malaysia. Those objectives will show the important of the implementation of LCC in construction industry especially during in
operation and maintenance phase. Those objectives will integrate life cycle costing model in construction industry.

According to Arja et-al (2009), for further suggestion is that the LCC analysis should be developed and extent in application for different type of building to obtain more reliable results and different LCC formulae to contribute to other functions of building services such as building design and costing, in decision making and planning process.

8. CONCLUSIONS

As a conclusion, consideration of economic concept of time value of money involves variables such as cost, time and also discount rate (Cryder & Lally, 2008) in order to compare the amount of money that will be spent over an extended number of years.

This research also will provide benefits and advantages not only to the building management but also favourable to the government bodies involved in the construction sector and to overcome certain problems in maintenance phase through the life cycle cost approach in government building. It also can create an effective and safe environment that is comfortable to the occupier. The building work will increase productivity indirectly, increase the value of investments and reduce maintenance costs. From the study that has been conducted, perhaps it will be parallel with the objectives that achieved through the methods which have been stated earlier.

ACKNOWLEDGEMENT

I would like to sincerely thank Associate Professor Dr Hj Zainal Abidin Akasah as my supervisor for the feedback throughout the research and the writing process of this paper. My profound appreciation to Universiti Tun Hussein Onn Malaysia (UTHM) in giving me the opportunity to doing this study and not forget especially my family and friends are always giving support, encouragement and support in completing this study.

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