

## **An Exploratory Review of Whole Life Cycle Costing for Malaysia Property Development**

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### **Abstract**

*The demand of implementing Whole Life Cycle Costing (WLCC) towards property development has increased since the launch of Value Management Circular 3/2009 by the Economic Planning Unit Malaysia. The circular made compulsory for all public construction projects and programmes including property development estimated more than RM 50 Million to conduct WLCC. However, a knowledge gap on WLCC approach still exists and becomes a barrier among the practitioners in Malaysia particularly in property development industry. The main focus of this paper is to explore and disclose the necessary requirement to ensure the WLCC approach can be implemented successfully in Malaysia such as other developed countries. This research has been done by reviewing and analysing all the related empirical researches and supported with surveys among twenty property managers in Malaysia. As a result, structured evaluation documents and indicators have been determined to be considered in Malaysia property development decision making process.*

**Keywords:** Property Development, Indicators, Property; Making process.

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## **INTRODUCTION**

Since the 1980's, economics has had to come to terms with the wider concepts of quality growth and eco-development. As organizations become increasingly aware of environmental costs (soil, water, wastewater and tree) and management costs (operation, maintenance and replacement), whole life cycle costing (WLCC) becomes more and more important to assess, predict and trace all the costs involved.

This property management growth creates a new phenomenon especially in terms of budgeting. As far as property management is concerned, there is an increasing awareness of the importance of considering the cost of buildings in use and of developing financial techniques to evaluate the WLCC of building in use too. Every property requires an investment and each exploitation process requires management. For each type of investor the goal has to be clear and related to the proper investment criterion, in which the importance of rental income and cost has been well defined. In all cases, usability and adaptability have to be taken into account, though to different extents.

## **ISSUES ON WLCC AND PROPERTY DEVELOPMENT**

A project is an organized set of activities aimed at accomplishing a specific project. Projects are typically performed under time constraint, limited budgets, tight cash flows and uncertainty using shared resources. Many projects, particularly large projects, evolve over long periods. Costs incurred in one period may generate benefits for many years to come. The evaluation of whether these projects are worthwhile therefore must compare benefits and costs that occur at different times.

The operation of the residential property market is the focus of most public scrutiny in Malaysia. The development cost, limited land area, and the development demands are among the top issues that have been discussed publicly (Tapsir, 2001). With regards to these situations, author decided to search for best approach for the Malaysian property development by exploring and introducing the WLCC as an alternative approach. WLCC is a relatively new concept for the construction industry especially on property development and particularly for Malaysia. Establishing and defining the application of Whole Life Cycle Costing for the Malaysian property development process is the specific aim of this paper. WLCC is rapidly becoming the standard guideline for the long term cost appraisal of buildings and civil infrastructure projects (Kirkham, & Boussabaine, 2005).

Construction Industry Development Board, (CIDB) (Malaysia) announced in Construction Industry Master Plan 2006-2015 that the construction industry has been under pressure for many years to produce economical buildings which offer value for money, not only during the construction phase, but more importantly, during the entire life cycle of the building. Attempting to balance between today's economic necessities and tomorrow's demands has been difficult and on many occasions future generations have been left to pick up the bill.

However, with modern technological breakthroughs and responsible manufacturers investing in their development, the situation is rapidly changing for the better. Although it is possible to claim that buildings are sustainable, for a holistic evaluation of the environmental impact a building makes on the environment, an objective analysis is required. While such an analysis should consider both operating as well as construction requirements of various buildings, the evaluation should cover the total useful life of such buildings (Pelzeter, 2006).

Besides, it is readily accepted that considerations such as the quality of design, materials used and workmanship affect the current and future OMR (Amadi-Echendu, 2004). Ultimately, the WLCC of any structures being constructed to overcome that condition. Property managers are forced to make cost reduction decisions in every part of development from the inception up to the disposal stage knowing that their decision today may significantly impact current and future cost,

thus whole life cycle cost. They need to determine how and when to repair older equipment while at the same time minimizing cost and maximise value with limited OMR budget allocations.

Furthermore, they have to balance the need to maintain older development equipment with a requirement for new construction. Thus, according to study by DTI (DTI-Bourke et al., 2005), quantifying the impact of quality upon WLCC and developing a simple formula that uses a building design, construction, operation and maintenance quality to predict WLCC or even operation, maintenance and rehabilitation costs, would be valuable tools for property managers, developers and surveyors.

In practice, several problems or deficiencies have been identified in connection with both estimating the future cost and tracking the historical cost behavior of products, customers or other cost items over a long period (Bryan, 2005). Pelzeter, (2006) has found that more than half of companies do not have specific decision support system for their investment planning. Naturally, the long term cost structure is essentially dependent on the type of material in question, but overall effective cost management covering the entire life cycle of products is very important for the organization. Quite recently, the organization has increasingly struggled with high cost associated with using products, which has resulted in demands to lower product quality and overall utilization rate of many products (Amadi-Echendu, 2004). According to previous studies, the design decisions are evaluated by individual house owners based on the value provided for the money (Beaver, 2000 & Jones, et. al 2000). Therefore the initial and more importantly the whole life cycle cost of design decisions becomes one of the critical success factors for the development.

Recently, multi million ringgits Malaysian Ringgit (RM) in respect to the country involved) have been invested in low cost multi storey residential property projects, a major concern for decision makers is the on-going maintenance costs for the residential property developments (13,20,26,27). With little attention paid on what happens during the life span, it is no surprise that most public residential property development management face lack of budgeting for OMR costs of building components (Tapsir, 2001). Based on the Malaysian construction industry, residential property development contributes more than 5-6.5% to a major amount of the nation's economy per annum (CIDB 2010, Government of Malaysia 2010 & Mohd Talhar, 2004). It is well established that construction industry is the first to be affected during economic downturn and the last to make progress when the economy recovers. These situations show that, the expenditure of the property development increase constantly especially n residential property development.

Despite the economic issue that is not within the control of the industry, there are other aspects that are controllable by the industry. They are quality, costs and speed of construction. Reflecting on these problems, the issue of not taking consideration of the expenses and on-going cost during the life span of the residential property development at the initial implementation stage has a major impact on the long term viability of the development. Often these long term cost are not realized by the client, as they are not immediate in the initial development stages.

It is widely recognized that the quality of design is crucial to the success of the construction or production process (McGeorge & Palmer, 1997)). Fairly minor changes in design will give major effects on the cost and efficiency of production and construction as well as on the usefulness and marketability of the product. The situation has been recognized that the goal of lowest construction cost is often not well served by minimizing material costs, as ease of construction has a major influence on the total cost. The critical influence of the design on construction costs was pointed out by Paulson (1976), which he expounded the level of influence concept. This denote that ability to influence cost decreases continually as the project progresses from 100% at project sanction, to typically 20% or less by the time construction starts. The point of Paulson's argument is that the greater part of management effort to control costs is applied to the construction phase, where its potential effectiveness is very limited.

The world is now undergoing very rapid changes with new technologies affecting all aspects of society. The present values in society are also under constant scrutiny and evolution. Therefore, it is virtually impossible to predict how these factors might influence the future. In the case of building and civil engineering construction industry, the capital cost of construction is almost always separated from the cost of maintenance. The cost of disposal or demolition is rarely

a design consideration. It is a normal practice to accept the cheapest capital construction cost and then hand over the building structure to others to maintain. What is needed in the construction industry is the WLCC approach to the purchase cost, the maintenance cost, the running cost, the cost of in service failure and the demolition and disposal cost of a building structure.

The essential problem in evaluating projects over time is that the money has a time value. Reflecting of this scenario, economic and value must also be taken into account in the evaluation. From a practical point of view, the analytical solutions are delicate and must be interpreted with care. Therefore, the evaluation that should be considered must involved mixture of art and science. In order to appreciate that condition, the WLCC has been chosen as an alternative approach for this situation. The need for WLCC arises because decisions made inevitably have an impact on future outlays as the design evolves and product mature especially during the early phases of a project development (Amaratunga, et al., 2002).

## **IDENTITY OF WHOLE LIFE CYCLE COSTING**

From this author's perspective, WLCC is the most relevant cost management method. Many of the most prominent LCC methods (Amaratunga et al., 2002) and then enhance by Kirkham and Boussabaine (Kirkham et al., 2005), known as WLCC methods are intended to be used to support design decision making, from a client's perspective. As from manufacturer's perspective, Dunk (2004) presents motivational factors for using WLCC: manufacturers with a strong customer-focus may recognize WLCC as a customer service leading to competitive advantage. However, the ability of a manufacturer to perform WLCC is affected by the quality of information available.

Moreover, the traditional settled economic and social order was turning into something more sophisticated and dynamic and the project themselves were of an increasing technological complexity and innovation. These are other reasons why this approach should be taken into consideration for the property development process. Bryan (2005) stated that there are two reasons why this approach should be considered. They are;

- i. The people commissioning large projects were increasingly cost conscious, being either industrialists concerned with profitability, government bodies concerned with accountability, or joint stock companies concerned with both.
- ii.
- iii. The most cost planning can do is to help use the total allocated funds more effectively within the current framework of rules, and accept that the basic values will be decided for political reasons.

A review of current and recently published research found that considerable work has been done on the areas of service life planning, life cycle costing, activity based costing, WLCC and property management. The empirical research also focuses their studies towards building conditions. Implementation of WLCC and how it can be measured in construction phase of a construction project is similarly well documented. It was found however, that little research has been carried out on how to measure the WLCC towards the materials, OMR phases of a building's life. Furthermore, no substantial body of work exists that thoroughly computes the implementation of WLCC over the property development building. Even though, there has been one study on implementing WLCC on the residential property, but they only focus at the end which is towards the energy consumption of the residential property which is only a part of the property development building element. This body of research has been restricted to the developed countries such as United State of America, United Kingdom, Germany New Zealand and Australia, but there has been very limited research on this topic in Malaysia.

The total cost of a building includes all costs associated with the design, construction, operation, maintenance, rehabilitation and disposal or demolition of the asset at the end of its useful service life. The cycle phases include the following (Fabrycky et al., 1991, Kirkham et al., 2005 & Norvick, 1990);

- i. Capital programming (Capital sums, now or in the future)
- ii. Concept study and analysis of alternatives
- iii. Design, drawing and contract document preparation
- iv. Construction
- v. Operations and inspection
- vi. Maintenance, repair and rehabilitation
- vii. Reconstruction, replacement or disinvestment (demolition or disposal)
- viii. Recurring costs
- ix. Sinking fund (to repay the capital when the asset is life expired)

As indicated in Table 1, economic interest or economic service life refers to the financial investment that the property manager (PM) has in the building and the actual outlay of money by the PM for the design, construction and OMR of the building over a specified period of time. It does not mean the monetary interest rate or discount rate used in the calculation of the costs. The cost arises only as a consequence of consuming some resource or asset which must be paid for or whose value is denied to some other use (Bryan, 2005). Cost is a dependent variable that can only be measured or forecasted in terms of the resources entity. Thus, the WLCC work is an attempt to model the acquisition and operating processes in terms of the resources consumed and to convert all these resources to a single baseline cost total and cost profile.

**Table 1: Comparison of terminology use to define life cycle cost**

<b>Terminology</b>	<b>Definition</b>	<b>Researcher</b>
<b>Life Cycle Cost</b>	All significant costs of ownership over the economic life of an asset.	Dell' Isola & Kirk (1981)
<b>Life Cycle Cost</b>	The sum of all costs that are expected to be incurred as the asset performs its function over a period of time.	USACE (1987)
<b>Life Cycle Cost</b>	Total costs to construct, operate and maintain asset.	Neely & Neathammer (1991)
<b>Life Cycle Cost</b>	The costs associated with acquiring, using, caring for and disposing of physical assets.	Al-Hajj & Horner (1998) after BS3843 (1992)
<b>Life Cycle Cost</b>	All costs associated with an asset over a fixed analysis period.	Hudson, et. al., (1997)
<b>Total Life Cycle Cost</b>	The cost from concept design through to occupancy and ultimate demolition.	Wall & Smith (1998)
<b>Whole Life Cycle</b>	Consideration of the costs associated with the whole building life and not just the period of economic interest.	Bourke & Davies (1999)
<b>Life Cycle Cost</b>	The costs associated with the period of economic interest.	Bourke & Davies (1999)
<b>Whole Life Cycle Costing</b>	The systematic consideration of all relevant costs and revenues associated with the acquisition, use, maintenance, and disposal of an asset.	ISO (2000a) ISO 15686 Part I

Source: Plezeter (2006)

## **EVALUATION DOCUMENTS**

Documentary information is used to study and identify past decisions made, information on project details, personnel involved and to corroborate evidence. Documents expected to be reviewed in defining the application of WLCC are as follows;

- i. Building Data Collection
- ii. Historical Data
- iii. Analysis of Official Documents
- iv. Reviews on Codes, Standards, and Equipment Specifications
- v. Data Determination and Validation
- vi. HRRPD Building Cost Data
- vii. Operation, Maintenance and Rehabilitation Costs
- viii. Building Service Life Costs
- ix. Service Life System
- x. Building Component Predicted Service Life

### **Building Data Collection**

In implementing this application, PM requires an in-depth knowledge of all the factors involved and analyze critically in choosing the building data. Holmes (1990), Tucker (1990) and Al-Hajj (1999) on their building cost analysis included the collection of all the data such as condition assessment, cost information, component service life, design details, maintenance history and quality of the building as the date and day of inspection.

All the data mentioned was important to establish this approach. PM needs to conduct site visits to obtain all the data on the schedule basis. In verifying the PM understands the property development process, existing policies and procedures must be examined. All the information including development reports, financial reports and property records should be obtained as well.

### **Historical Data**

The historical data must be collected throughout all the related property development. Basically, the challenges of collecting the historical data are the validity of the data, accessibility of the data, the availability of the historical records and the accuracy of the source. In regards to these issues, PM needs to provide the accurate time in checking and inspecting the historical data thoroughly.

### **Analysis of Official Documents**

In order to understand all the data and components due to the related property development, PM needs to review all the official documents involved starting from the proposed development project till the current maintenance of the property development. The official documents such as construction documents and specifications, AutoCAD Drawing, finishes schedules and purchase invoice must be reviewed deeply and critically.

Those documents provided the information regarding the building components, the type of material used, the manufacturers, initial cost, total area for each material been used and the systems specification. Besides that, the related document will also provide the information of the building plan (layout), location, and size of the building.

### **Reviews on Codes, Standards, and Equipment Specifications**

Once the building components were identified, manufacturer's technical specification data sheet will be collected. For each component, manufacturer's technical specification data sheets provide information regarding the materials characteristics, recommended cleaning and maintenance procedure and expected durability. All these information must be used to compare the actual cleaning and maintenance procedures with those outlined by the manufacturer. In addition, the Minimum Standards of Housing and Amenities Act 1990, Uniform Building by Law 1984 (Act 133 amends May 2006), and Guidelines used for Standards and Cost of Building Planning by

Standard and Cost committee (2008) must be referred as a basis for refining the list of components alternatives.

### **Data Determination and Validation**

Based on the previous studies, it appears that the WLCC can be implemented with several methods. Two methods have been widely applied, which are namely historical cost data and theoretical cost data. The first method uses historical cost data to obtain a real WLCC. Historical cost data are rarely used as it is unusual for most organization to have complete historical cost records. The second method and frequently used method uses the theoretical cost data to obtain an estimated WLCC. This is then used in comparing the component alternatives. At this stage, both of these methods will be used to calculate WLCC in this research because of the uncertainties with the information that will be received.

### **HRRPD Building Cost Data**

All the building cost data of the property development must be determined as clear as PM is concerned. The appropriate and correct data will help in identifying the best result of this approach. WLCC of the property development is the sum of all costs incurred by the facility over its life period. These costs are define as construction and inspection costs, design costs, risk costs, OMR costs including taxes, administrative overhead and acquisition costs. WLCC can also cover the cost of lending or buying and non agency costs such as user and environmental costs (Hudson et. al 1997).

### **Operation, Maintenance and Rehabilitation Costs**

Maintainability can be defined as ease of which the maintenance activity can be carried out on an item of product or system (Rosenberg 2000). Derived from equipment and supplies used, time consumed for each procedure, the required frequency of performance, the number of people involved and the wage and labor fees for the custodial staff.

As brief information above, however, the OMR costs can be determined based on the historical OMR costs data. To overcome any uncertainties, a more detailed analysis is then must be undertaken to determine the completeness of all the maintenance cost especially the other maintenance cost such as emergency repairs, minor routine and preventive maintenance that may be overlooked by the person in-charge.

### **Building Service Life Costs**

There are too many things to be determined on building service life costs as it is the most critical and difficult costs to determine. As the best reference that can be used to establish the building service life costs is the 'Cost and Planning Manual' provided by the property development management team themselves and 'Costing Manual' provided by Ministry of Works Malaysia. Amaratunga, et. al., (2002) mentioned that, the sensitivity analysis is the best approach to determine the building service life costs and it is totally can be reflected by the economy fluctuation at the time referenced.

### **Service Life System**

The service life system for building has been classified to three types of service life systems which are design service life (DSL), actual service life (ASL) and predicted service life (PSL). According to (Amadi- Echendu 2004, Amaratunga, et. al., 2002 & Dunk 2004) the more durable and better maintained a building or its component, the longer it should be performed without failure. The actual service life system for building components war intrinsically linked to the quality dimensions of durability and serviceability.

### **Building Component Predicted Service Life**

In analyzing the WLCC, information of the life span must be taken into consideration. This assumption will be guided in computing the correct calculation of WLCC. As mentioned in BSI, 1997, the Factor Method was used to calculate the predicted service life for individual building

and critical components and was used in the quality scoring metric. Nevertheless, this method is normally used to consider the variables that may affect service life but it is also useful as a tool to determine how an existing component has performed in comparison to the predicted service life. The advantage of this approach is that when the Factor Method is used ‘in arrears’, known values rather than assumed values can be used as a benchmark for the factorial scores. The formulae for the building component assumption service life as stated in equation 1.

$$PSL = DS \times A \times B \times C \times D1 \times D2 \times E \times F \quad (1)$$

Where,

<i>PSL</i>	= Predicted Service Life
<i>DSL</i>	= Design Service Life
<i>A</i>	= Component Quality
<i>B</i>	= Design Factor
<i>C</i>	= Workmanship Factor
<i>D1</i>	= Internal Environment Factor
<i>D2</i>	= External Environment Factor
<i>E</i>	= In-Use Factor
<i>F</i>	= Maintenance Factor

## ECONOMIC ANALYSIS APPROACHES

Arditi & Messiha (1999) pioneered the recommendation that all WLCC calculations should be in constant year dollar (Malaysian Ringgit (RM) in respect to the country involved) and a discount rate to be used to negate the impact of inflation. For historical costs to be accurate and comparable for use in WLCC, they need to be converted into constant RM first and then adjusted to account for time value for money.

### Determination of property development economic model

Several models or indices exist to convert current year RM into constant RM. The property development economic model was selected over other indices, such as Building Material Price Index and Consumer Price Index. As one of the most important items in cost data, particularly with regards to forecasting techniques, which rely on historical data, is the cost index. The objective of the cost index is to measure changes in the cost of an item or group of items from one point in time to another. A base date is chosen and is usually given the value of 100, all past and future increases or decreases being related to this figure. By applying the indices to work undertaken during a specified period, it is possible to evaluate, to an acceptable degree of reliability, the increase in cost of resources to the contractor since the date of tender. This enables the financial control of contracts, which adopt fluctuations clause to be exercised more speedily with less ambiguity. Accordingly, the economic model was then applied, using equation 2, to convert all property development building costs into constant year RM and to calculate building components WLCC to date.

Property development WLCC;

$$= [EFC_j \times (ICC)_j] + [EFC_k \times (ACC)_k] + \sum_{t=1}^{t=n} EFM_t \times [(M)_t + (R)_t + (U)_t + (CEPers)_t + (PILT)_t] \quad (2)$$



Where,

$EFC_j$	= the property development economic model construction factor for the year of construction.
$EFC_k$	= the property development economic model construction factor for the year of construction.
$(ICC)_j$	= the one time initial construction cost in year $j$
$(ACC)_k$	= the one time additional construction cost in year $k$
$t$	= the year of cost is incurred
$n$	= the actual service life or period of economic interest
$EFM_t$	= the property development economic model operation and maintenance factor for the year $t$
$(M)_t$	= the sum of maintenance and repair costs occurring at year $t$
$(R)_t$	= the sum of rehabilitation costs occurring at year $t$
$(U)_t$	= the annual building service costs occurring at year $t$
$(CEPers)_t$	= the annual construction engineering personnel costs occurring at year $t$
$(PILT)_t$	= the annual payments in lieu of taxes occurring at year $t$

### Annual Equivalent Cost

Even though PM already determined the property developments costs, but, the annual equivalent costs are also important to be determined. This annual equivalent costs will help to determined how building component costs appreciate with each other, how they compare within categories, and how to evaluate the impact of factors such as quality or usage. It is more useful to convert WLCC to date into annual equivalent costs. As an equivalent annual cost method is a standard economic analysis that presents all initial costs and recurring costs as equal annual payments over a specified analysis period taking into account the time value of money (Bowman, 1999). All costs need to equivalent in constant year RM prior to conversion to annual equivalent costs. The basic formula for determining annual equivalent costs (AEC) is expressed in equation 3a-b.

$$AEC_n = crf_n [ICC + \sum_{t=1}^{t=n} (M)_t + \sum_{t=1}^{t=n} (R)_t] + (U)_t + (CEPers) + (PILT) \quad (3a)$$

$$crf = I(1+i)^n + [(1+i)^n - 1] \quad (3b)$$

Where,

$AEC_n$	= the annual equivalent cost for period of $n$ years.
$crf_n$	= the capital recovery factor for a period $n$ years at a discount rate $i$
$ICC$	= the initial construction cost in constant RM
$t$	= the year of cost is incurred.
$n$	= the actual service life or period of economic interest.
$i$	= the interest rate occurring at year $t$ for period of $n$ year.
$(M)_t$	= the sum of maintenance and repair costs in constant RM occurring at year $t$ for period of $n$ year.
$(R)_t$	= the sum of rehabilitation costs in constant RM occurring at year $t$ for period of $n$ year.
$(U)_t$	= the annual building service costs in constant RM.
$(CEPers)_t$	= the annual construction engineering personnel costs in constant RM.
$(PILT)_t$	= the annual payments in lieu of taxes in constant RM.

### **Determination of Inflation rate**

Inflation rate is used to inflate the capital cost of each material alternative to determine the replacement cost. It also to inflate the OMR cost associated with any given materials (Moussatche et al., 2002). In the long run, when all adjustments have occurred, the increase in inflation is fully incorporated in nominal interest rates.

### **Determination of Discount rate**

In practice, estimating the discount rate is not a straightforward matter. Most of the public projects and private projects are financed by more than one budget source. The choice of the discount rate is one of the most debatable topics in this research. The Principles discount rate will be based on an opportunity cost concept, being the market risk adjusted interest rate applicable to the loan in question. Typical WLCC uses a discount factor when there are current funds available for future OMR cost of an asset since some institution allocate budget for future OMR (Moussatche et al., 2002).

## **CONCLUSION**

From existing literature review and based on the pilot study conducted at the outset of this study, it is essential to explore and identify the application of WLCC in Malaysia property development. WLCC will bring more advantages than disadvantages to the property manager, thus, ways to enhance WLCC should be implemented in the Malaysia property development sector. By exploring the application of WLCC, this will assist property managers, to manage the WLCC of the Malaysia property development sector. Subsequently, by explaining this application, it is projected that all the necessary indicators of the application could be used to conceive new prerequisites for Malaysia property development policies. In this way, decision makers will have more knowledge about the expenditure and the budget allocations of the development throughout the project. This application supports policy packages that provide economically viable, environmentally friendly and sustainable property development sector in Malaysia.

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