

TECHNICAL ARTICLE

Assessment of the Problems of Application of Life Cycle Costing in Construction Projects

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ABSTRACT: This article discusses the problems of applications of life cycle costing in construction projects in Saudi Arabia. Twenty-six problems were identified and classified into five major groups. A survey of 11 government agencies and 12 consulting offices that apply life cycle costing was conducted through a structured questionnaire. The collected data was analyzed. The severity index for each individual party was calculated providing the basis for statistical measures. It was agreed by both government agencies and consultants that the chief cause for not applying life cycle costing is the client or management pressure to meet the deadlines for design approval. They also agreed that the lack of human and material resources are also another reason for not applying life cycle costing more extensively.

KEY WORDS: Life cycle costing, data, management, and research

Life cycle costing is the economic assessment of alternative designs, construction or other investments considering all significant costs of initial costs, and ownership costs over the economic life of each alternative, expressed in equivalent economic units. These costs include the initial cost, operation and maintenance costs and finance costs over the life time of the asset. The technique has obvious advantages and it makes sense to apply it in all decision making concerning the selecting of alternatives. However, there are some practical problems in its application. The objective of this article is to discuss these problems and to assess their extent in the Saudi construction industry.

PROBLEMS OF APPLICATION

There are five main categories of problems of life cycle costing which includes knowledge, data, procedure, management and cost problems. Each problem will be discussed briefly.

Knowledge Problems

- **Unfamiliarity With the Design-to-Cost Concept**—A design-to-cost con-

cept means that the building selection and design system will be based on the total cost of the building along its life cycle. In some instance, system alternatives are evaluated using such analysis but this is an exception rather a rule.

- **Lack of Knowledge of the Concept**—Many clients are unaware of the technique of life cycle costing and how it could help them to make a better investment decision.
- **An Unknown relationship Exists Between Initial Cost and Future Cost**—Some decision-makers concentrate on the initial cost of a product or building and are not concerned with future running cost. Pressures on management to improve short-term gains emphasizes this thinking. In fact, in most cases initial cost is not the largest single cost and it is under 50 percent of the total ownership cost of the project.
- **Unavailability of Enough References**—Because of the shortage of technical papers published on the subject of life cycle costing, the concept tends to not be well known to most decision-makers in the construction industry.

Data Problems

Life cycle costing is heavily dependent on data. The data used should be for projects that have been completed and should include all types of data, such as cost, performance, occupancy and general description information. In the collecting and analyzing of data, the designer will be faced with many problems, including the following.

- **Unavailability of Capital Cost Data**—This includes all data associated with development of a facility and includes data related to fees, site, and other construction costs.
- **Unavailability of Maintenance Data**—This includes all data associated with maintenance of a facility in use and includes data for regular repairs, predictive maintenance, and annual maintenance contracts.
- **Unavailability of Operation Data**—This includes all data associated with operating a facility, such as fuel, salaries of operators, and energy costs.
- **Unavailability of Discount or Interest Rate Data**—The interest rate incorporates both time and value of money, whereas the discount rate will be extracted from inflation. Selection of the discount rate should reflect the level of return on alternative investment or on the cost of borrowing the money.
- **Unavailability of Time Life Data**—This includes all data associated with an item's life or expected time for replacement.
- **Large Volume of Data Needed**—The volume of data that must be filtered in life cycle costing to obtain information is enormous. The information derived from these data is used as input for making an equally large number of decisions.
- **Unavailability of a Standard Method for Collecting and Recording Data**—Ordinary collection of data by a client is done for accounting purposes that could not be used in life cycle cost calculations,

Performance data will be more beneficial to life cycle costing than accounting data. There is no effort that has been done to establish a methodology for collecting and analyzing data.

- **Unavailability of a Data Base Management System**—A data base management system is needed that will provide structuring facilities with a system that is capable of expressing the relationship between the data items used for life cycle costing

Procedures Problems

- **Unreliability of Decision Taken**—Alternatives should be investigated in simple and functional comparison. Any design decision will have an effect on the whole life cycle. In order to have reliable decision, the past experience of designers should be examined to verify reliability.
- **Lack of Integrity of Forecast**—In order to have integrity of forecast, information should be expressed in the context of what could happen, what should happen, and what did happen.
- **A Majority of LIFE CYCLE COSTING Calculations Involve Uncertainty**—The decision is said to be uncertain if it has several possible outcomes. Most of data in life cycle costing is uncertain because much of it relates to the future, which will be affected by inflation and other factors. Assumptions and forecasts are made about cost of energy, cleaning, maintenance, etc.
- **Unavailability of Qualified Staff**—The availability of a qualified staff, including quantity surveyors who can cover all phases of life cycle costing including the selection, study, generating of alternatives, and design evaluation will help in providing good results. The quantity surveyors need to have a flexible approach to life cycle costing and provide the required services.
- **Unavailability of Qualified Consultants**—The availability of qualified consultants that have certified staffs can help in doing life cycle costing.

Management Problems

- **Unacceptance of the Concept**—Some decision-makers do not accept the concept of life cycle costing and consider only initial cost in their selection of alternatives.
- **Government Non-Enforcement**—Some agencies or firms will simply carry out a system as far as it is requested by the government and consider the design job as routine work that does not have any room for improvement or introduction of good techniques. In the US, there has been a mandatory requirement for life cycle costing to be conducted in procurement work for all federal budget projects.
- **Management (Client) Pressure to Meet Budget Limits**—Budget limitations on construction resources are one of the problems that can obstruct the application of life cycle costing to search for alternatives.
- **Management (Client) Pressure to Meet Time Deadlines on Design**—There will always be pressure to meet design deadlines that could effect any study regardless of the quality of the design team.
- **Unclear Benefits of LIFE CYCLE COSTING to Management (Client)**—An unclear knowledge of services that life cycle costing could provide is one of the problems in application. Life cycle costing can provide many services—it can give support for maintenance and operating budget, it can be used to compare alternatives, can be used for planning, etc.
- **Improper Planning and Control of Management Tasks at Different LIFE CYCLE COSTING Stages**—Although the concept of life cycle costing is used by some industries in the US, the cost goals are still not achieved because of a lack of proper planning and control of the management tasks at the different stages of the life cycle.

Cost Problems

- **Cost to be Paid for Designer to Conduct LIFE CYCLE**

COSTING—In order for life cycle costing to be conducted efficiently, the designer should be paid for his effort.

- **Cost to be Paid for Collection of Data**—Data collection is not free. There is a cost to collect and analyze data that has to be considered in life cycle costing.
- **Difficulties in Defining Cost Elements**—It is not easy to identify all cost elements for each facility when you conduct life cycle costing.

RESEARCH METHODOLOGY

This investigation was undertaken in two phases. The first included literature searches and interviews. The result of the first phase was identification of five groups of main problems and a total of 26 specific problems of application of life cycle costing in Saudi Arabia. In the second phase, a questionnaire was developed using the specific problems and a survey was conducted to assess the relative severity of these causes. The questionnaire was filled by 11 government agencies and 12 consulting offices that apply life cycle costing.

RESULTS OF THE SURVEY

Based on a survey of the responses, a severity index was calculated to reflect the severity of each individual problem and problem groups. The severity index was calculated as follows:

Where:

a_i = constant expressing weight given to i ,

x_i = variable expressing the frequency of responses for $i = 0, 1, 2, 3, 4$.

$$\text{Severity Index} = I = \frac{\sum_{i=0}^{i=4} a_i x_i}{\sum_{i=0}^{i=4} x_i} \times 100$$

The average index for the problem group in the application is the average of each individual problem in same group.

The severity indexes were grouped to reflect the respondents' ratings as follows:

Strongly severe	$87.5 < I \leq 100$
Severe	$62.5 < I \leq 87.5$
Somewhat severe	$37.5 < I \leq 62.5$
Somewhat not severe	$12.5 < I \leq 37.5$
Note severe	$0 < I \leq 12.5$

Table 1 shows the severity index for individual problems in government agencies while table 2 shows the severity index

for individual problems in consulting offices. In the same manner, table 3 shows the severity index for problem groups in government while table 4 shows the severity index for problem groups in consulting offices. Based on the foregoing classification, the following could be indicated.

For Government Agencies

- **Individual Problems**—Twenty-four individual problems rated “severe” and two individual problems rated “somewhat severe”.
- **Problem Groups**—Four groups fall in the “severe” category and one group falls in the “somewhat severe”.

Table 1—Results of Government Agencies’ Survey of Problems

Problem Definition [1]	Strongly Severe [2]	Severe [3]	Somewhat severe [4]	Somewhat not severe [5]	Not severe [6]	Severity Index [7]
(a) Knowledge Problems						
Unfamiliarization of design-to-cost concept	4	2	4	0	1	68
Lack of Knowledge of the concept	5	3	2	1	0	77
Unknown relation between initial and running cost	2	3	5	1	0	64
Unavailability of satisfactory references	5	2	3	0	1	73
(b) Data Problems						
Unavailability of capital cost data	3	3	3	1	1	64
Unavailability of maintenance data	4	4	1	2	0	73
Unavailability of operational data	4	3	3	1	0	73
Unavailability of interest rate data	4	3	3	1	0	73
Unavailability of time life data	3	3	5	0	0	70
Large volume of data needed	2	5	4	0	0	70
Unavailability of standard method for collecting and recording of data	3	2	4	2	0	64
Unavailability of data base management system	2	4	3	2	0	64
(c) Procedure Problems						
Unreliability of decision taken	4	1	6	0	0	70
Lack of integrity of forecast	3	3	5	0	0	70
Majority of LCC calculations involve uncertainty	3	4	4	0	0	73
Unavailability of qualified staff	4	3	3	1	0	73
Unavailability of qualified consultant	6	2	3	0	0	82
(d) Management Problems						
Unacceptance of the concept	3	4	2	2	2	54
Government non-enforcement of LCC	4	2	5	0	2	58
Client pressure to meet the capital budget limit	4	3	3	2	2	52
Client pressure to meet time deadline on design	5	3	4	1	1	63
Unclear benefits of LCC to client	2	4	3	1	1	65
Improper planning and control of management tasks at different LCC stages	2	2	7	1	1	52
(e) Cost Problems						
Cost to be paid to designer to conduct LCC	1	4	5	1	0	58
Cost to be paid for collecting and analyzing of data	1	4	6	0	0	58
Cost problems/difficulties in identifying components	1	3	6	1	0	48

For Consulting Firms

- **Individual Problems**—Six individual problems rated as “severe” and 20 problems rated “somewhat severe”.
- **Problem Groups**—All groups fall in the “somewhat severe” category.

Other problems added by respondents included the following.

- **In Government Agencies**—Violation of the life cycle costing concept to government systems are based on initial cost in selecting alternatives and in bidding.
- **In Consulting Offices**—Resistance of management to introduction of

new concepts. Unclear concepts to clients, and time and cost incurred to update the in-house data base management system.

Based on the foregoing results shown in tables 1, 2, 3, and 4, the following could be indicated:

Table 2—Results of Consulting Offices’ Survey of Problems

Problem Definition [1]	Strongly Severe [2]	Severe [3]	Somewhat severe [4]	Somewhat not severe [5]	Not severe [6]	Severity Index [7]
(a) Knowledge Problems						
Unfamiliarization of design-to-cost concept	3	2	4	1	2	56
Lack of Knowledge of the concept	0	5	4	2	1	52
Unknown relation between initial and running cost	0	4	3	1	4	40
Unavailability of satisfactory references	1	2	7	0	2	50
(b) Data Problems						
Unavailability of capital cost data	2	1	5	0	3	48
Unavailability of maintenance data	2	4	4	1	1	60
Unavailability of operational data	2	5	3	1	1	63
Unavailability of interest rate data	2	5	4	1	0	67
Unavailability of time life data	3	4	3	1	1	65
Large volume of data needed	0	5	5	0	2	52
Unavailability of standard method for collecting and recording of data	2	5	3	0	2	60
Unavailability of data base management system	4	3	3	1	1	67
(c) Procedure Problems						
Unreliability of decision taken	2	2	3	4	1	50
Lack of integrity of forecast	3	0	6	2	1	54
Majority of LCC calculations involve uncertainty	2	3	4	2	1	56
Unavailability of qualified staff	3	2	5	1	1	60
Unavailability of qualified consultant	2	4	4	1	1	60
(d) Management Problems						
Unacceptance of the concept	2	4	2	2	2	54
Government non-enforcement of LCC	3	2	5	0	2	58
Client pressure to meet the capital budget limit	2	3	3	2	2	52
Client pressure to meet time deadline on design	3	3	4	1	1	63
Unclear benefits of LCC to client	3	4	3	1	1	65
Improper planning and control of management tasks at different LCC stages	1	2	7	1	1	52
(e) Cost Problems						
Cost to be paid to designer to conduct LCC	3	3	2	3	1	58
Cost to be paid for collecting and analyzing of data	3	2	4	2	1	58
Cost Problems/difficulties in identifying components	1	2	6	1	2	48

Table 3—Severity Index of Problem Groups in Government

Group	Group Description	Average Sev. Index
A	Knowledge Problems	70
B	Data Problems	69
C	Procedure Problems	74
D	Management Problems	73
E	Cost Problems	61

Table 4—Severity Index of Problem Groups in Government

Group	Group Description	Average Sev. Index
A	Knowledge Problems	49
B	Data Problems	60
C	Procedure Problems	56
D	Management Problems	57
E	Cost Problems	55

For Government Agencies

- **Individual Problems**—Unavailability of qualified consultants, management pressures to meet budget, and design limits are the most severe hurdles in the application of life cycle costing, with severity indexes of 82 percent, 77 percent, and 77 percent respectively.
- **Problem Groups**—Procedure problems, management problems, and knowledge problems are the most severe hurdles in the application of life cycle costing with severity indexes of 74 percent, 73 percent and 70 percent respectively.

For Consulting Firms

- **Individual Problems**—Unavailability of data base management systems, unavailability of interest rate, and life time data are the most severe hurdles in the application of life cycle costing with severity indexes of 67 percent, 67 percent and 65 percent respectively.
- **Problem Groups**—Data problems, management problems, and procedure problems are the most severe hurdles in the application of life cycle costing with severity indexes of 60 percent, 57 percent and 56 percent respectively.

It can be concluded that government agencies and consulting firms, because of the differences of responsibilities and work interest, generally vary in their ranking of the problems that affect life cycle costing application. However, both parties agreed that the chief cause for not applying life cycle costing in government agencies or the public sectors is client or management pressure to meet deadlines for design approval. They also agreed that the lack of human resources (qualified consultants and staff) and material resources (sufficient data and data quality) are considered the main reasons for not applying life cycle costing more extensively.

SUGGESTED REMEDIES

- Introducing special programs designed for life cycle costing analysis, that is intended for use by all government agencies throughout specific formal procedures and standard data forms to ensure the appropriate database needed for life cycle costing analysis. This will not be a reality unless it is mandated by a government agency, such as the Department of Statistics, who will ensure its quality and make it easily accessible to the public through periodic publications.
- Government standards should be modified to suit the new technology related to material and should not stick to the old standards.
- Clients, consultants and other concerned parties should be introduced to life cycle costing so that they will understand and appreciate the life cycle costing concept. This will definitely help in minimizing the problems associated with applying life cycle costing in the construction projects in both the private sector as well as government agencies.

It is hoped with the above suggestion that most, if not all, of the 26 problems under the five main categories of problems concerning life cycle costing will be solved in a practical way ensuring more use of the life cycle costing concept in construction projects in Saudi Arabia.

Recommendations for Further Study

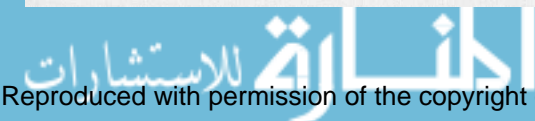
- Researchers have to search and identify options that would bring about the greatest potential in savings. This could be done by repetitive application of life cycle costing to variations of designs. The study could include the effect of building form on configuration of life cycle costing costs and the sensitivity of life cycle costing to the principal design options such as total area, cladding type, roof type, number of stories, etc.
- To identify and set standards for maintenance task which would satisfy the policies of government or clients.
- Explore the capability of the existing consulting offices to handle the life cycle costing studies in terms of technical capabilities such as availability of computer systems, staff experience, staff expertise, etc.
- Design an expert system that could select the proper materials assuming that life period, efficiency, maintenance costs, operating costs and other life cycle costing considerations will be given.

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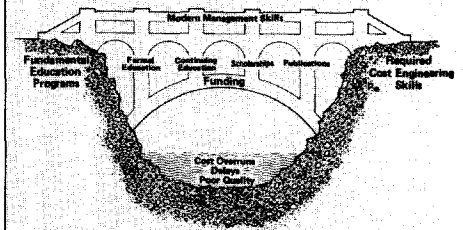
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