PERFORMANCE ASSESSMENT AND WHOLE LIFE COST COMPARISON OF SELECTED SUSTAINABLE BUILDING COMPONENTS OF ABC GREEN UNIVERSITY

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Abstract - The ABC Green University is constructed with the support of high technical methods and skilful labour. After analysing the built drawing and the final accounts, it was found that there are number of variations in the elementals and their costs, especially the cost of sustainable construction elements is comparatively higher. It is proved that the whole life cost of the sustainable construction increases due to the high maintenance cost and the replacement cost. Sustainable building design and construction is the practice of creating structures and using processes that are environmentally responsible and resource efficient throughout the life cycle of a building. In this research, it was aimed to conduct a performance assessment and a whole life cost analysis on sustainable construction elements of the ABC green University. The methodology adopted for the process is the case study method and the primary data was accumulated through interviews from the technical persons who have been involved in this project. Apart from that questionnaires were distributed among the expertise on the sustainable construction and the whole life cost procedures. Data analysis was done through a content analysis and descriptive data analysis. The findings exemplify that the cost of sustainable construction is higher in the short run and the cost can be covered in the long run. Though, proper cost benefit analysis should be done to each case before applying the sustainable construction methods. Further, it is recommended that the sustainable constructions should represent the real concept itself. Detailed performance assessment and a whole life cost calculation can be used to identify suitable alternative materials to reduce the cost.

Keywords: Performance Assessment, Whole Life Cost, Sustainable Building, Green University

I. INTRODUCTION

Background - In the concept stage of a construction project, the clients consider whether their investment for the project will be profitable at the end. The clients usually place high priority on cost of procurement and construction when deciding to commence the project. But most of the time the future costs of the building are ignored. If there will be high future costs comparing to the initial cost, it will affect the client's cash flow expectations negatively.

The main intention of the Whole life costing is to conduct a proper monitory assessment of assets over their life cycle considering cost factors such as, capital, operational, maintenance, repair, upgrading, and also cost of disposal. With better whole life cost analysis, sustainability of the building can be compared with the whole life cost and identify suitable remedies to increase the sustainability of the building cost efficiently.

When considering the construction industry, the application of whole life cost concept is barely identifiable. The main reasons for this is the lack of awareness regarding the concept of whole life cost among the industry professionals, unavailability of reliable data, and lack of expertise knowledge about identifying and estimating future costs.

The main objective of the research is to conduct a whole life cost analysis of selected building components of project X and to propose a solution for maintaining a data base for whole life costing purpose. , The analysis reveals

the importance of the use of energy efficient material for the building and possible alterations of the concept in order to make it popular in the industry.

Following building is selected for the quantitative and qualitative analysis of the whole life cost concept because the building is constructed after addressing all the parameters of the concept.

According to the literature review whole life costing which is also known as the life cycle costing was originally designed for investment purposes in the US Department of Defense. Whole life costing has many interpretations. As examples, According to Emblemsvåg (2003) Life Cycle Costing is; "the total costs that are incurred, or may be incurred, in all stages of the products life cycle". Dell 'Isola and Kirk (2003) clarified Life Cycle Costing as an economic assessment of an item, system or facility over its lifespan, expressed in terms of equivalent cost using baselines identical to those used for initial costs. Dhillon (1989) defines LCC as; "the sum of all costs incurred during the life time of an item, i.e. the total of investment- and operational costs". LCC is therefore based on an integrated approach with respect to the investment and operational costs.

The project x is constructed with the support of the high technical methods and the skillful labors from China, according to the built drawings and the final accounts there are number of variations in the elementals and its cost, especially the sustainable construction elements' cost is very high, and it is proved the Whole Life Cost of the sustainable construction will increase due to the high maintenance cost and the replacement cost.

Research Questions (research/sub-problems).

The following are the identified research questions:

I. Does the Contractor conduct a deep analysis on the Whole Life Cost?
II. Will it be possible to face technical and economic issues by a local contractor?
III. Are the contractors aware about the alternative sustainable materials in Sri Lanka?

Purpose of the Study/ Objective.

The Overall objective of the study was to find out the reasons for increasing WLC of the sustainable construction element in the project and suggest the suitable remedy to reduce the maintenance and the replacement cost of the Project:

Impact of the Maintenance and Replacement cost on the WLC of Sustainable components.

Impact of Technical and Economic factors on WLC.

To identify the suitable alternative Materials available to reduce the WLC.

II. LITERATURE REVIEW

Benefits of the whole life costing of sustainable(green) building has examined in this research based on the qualitative research methodology. With regard to this, gathering answers for the questioners from the expertise professionals has been conducted and simultaneously details from the literature study will also be adopted. According to the literature study, the main focus has been the Economic benefits of whole life costing, Qualitative benefits of whole life costing, Sustainability benefits of whole life costing, Process-related benefits of whole life costing and the disadvantages of whole life costing separately. But in this research, each of these criterions will be considered related to sustainable (green) building project. The findings of the questionnaire revealed that the issues regarding the implementation of whole life costing for building are as following,

Insufficiency of resources and competent personnel - Even though the implementation of whole life costing is possible in Sri Lankan construction industry the main limitation of it is there are no enough resources and personals who are competent enough to carry out the procedure.

Initially cost is relatively high - When considering the whole life cost the first in line consideration is the initial cost which is also known as capital cost (CAPEX). Initial cost of sustainable (green building) which is simply the construction cost is very high when comparing to a normal building construction cost. As an example, a sustainable building should be consisted of water management system and an air quality system. The initial installing cost of these systems is considerably high in comparison to other systems in a building.

Maintenance cost is relatively high - A sustainable building should be maintained in an efficient manner to have the

desired outcome (energy saving etc.). So that the operation cost which is also known as the OPEX is relatively high in a sustainable building.

Other than these main limitations of implementation of sustainable building there are issues such as the persons who are related to construction industry has a lack of interest with regards to sustainable construction concept. Because of these issues most of the employers are not intended in their project merging with the sustainable construction (green) concept. (Joost Lansink (2013), The Benefits of Applying life cycle costing method)

French architect Jean Francois Roger mention in his research that "whole Life Costing as common design methodology for building projects in Europe is one of them" This research mainly focused on how WLC is used to make investment decisions considering the environmental impacts. In this research it is attempted to find the alternative design approaches, and material selection which minimize the whole life cost and the environmental impact. In our research we compared whole life cost of different sustainable building construction solutions to choose the most productive alternative with in the sustainable material. (Jean Francois Roger France, Architect, MA (AA School London), Lecturer at the St Luc School of Architecture Brussels, Architect Council of Europe (ACE- CAE) Convener for the EEC in the Taskforce 4 WLC in Construction)

K. Hunter, J. Kelly and G. Trufil have conducted a research regarding whole life cost of a sustainable building design. This research was based on finding the micro economic issues regarding sustainable construction by analyzing a whole life cost of sustainable design. Also, the difficulties faced when adopting the sustainable practices through the life span of a project were identified. We in our research did not focus to solve the micro economic problems in the industry. We only focused on providing solutions for sustainable construction by using WLC and also advice the client on choosing a better alternative evaluating the result for a single construction project. (K. Hunter, J. Kelly and G. Trufil School of the Built and Natural Environment, Glasgow Caledonian University, Sustainability Centre Glasgow, Drummond House, 1 Hill Street, Glasgow, G3 6RN

A research regarding whole life cost concept towards building sustainability is another valuable research relevant to our research area. This research was regarding the difficulties faced in the implementation of whole life cost method due to unreliable data, price fluctuation and economic changes. According to the findings of this research, it is important to adapt the sustainable construction, which increases the value for the money for material and method used for the construction, rather than selecting non-sustainable construction alternative which helps to lower the tender price due to low initial cost. Also, they have found that the use of renewable energy technology will result in increasing the value of invested money. In our research we compared with in the sustainable alternatives use in different buildings to find the best solution and discuss about the employer's lack of knowledge regarding the evaluation of the results find through a whole life cost method. (Ing Liang Wong Glasgow Caledonian University, Conference Paper · February 2010)

III. METHODOLOGY

The research will mainly attempt to discuss the importance of the WLC calculation for the selection of an alternative material for the sustainable construction components. The Primary data which was required for this research is the most important part of the study. The primary data was collected via direct, indirect oral interviews with the technical persons who were participated in the project, mailed questionnaires from the expertise on the sustainable construction and the WLC procedure.

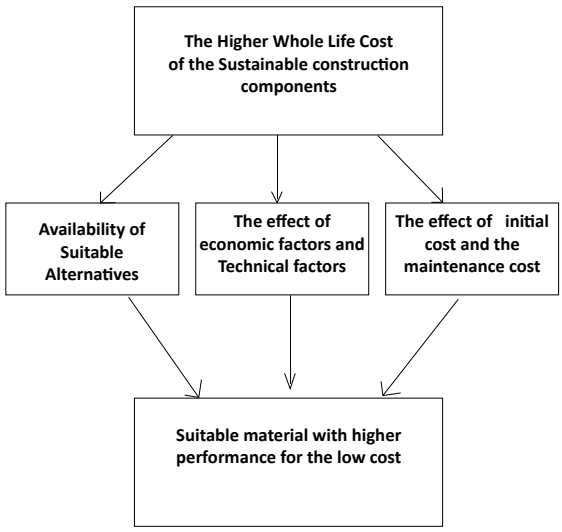

Figure 1 conceptual frame work
Source: Research objectives

There are some written material about the importance of WLC analysis, so the secondary Data research approach will be a collection of data through Journals and Articles which consist of related literature reviews of studies on importance of WLC analysis in the construction industry. Detailed whole life cost calculation will be used to identify the cost for the sustainable components which are used in the project X. The suitable alternative materials identified through the collected data from the primary and secondary approach and the Whole Life Comparison cost did for the alternative and identified the most suitable way to reduce the maintenance and replacement cost for the sustainable construction elements in the selected project. Data should be analyzed after preparing the whole life cost of each proposal and by comparing performance assessment the most suitable alternative material and the procedure proposed to the Contractor and the Employer.

IV. ANALYSIS

Sustainability is a universal concept. It is about consuming natural resources, the kind of legacy the current generation leaves for the future generations. At Present sustainability concepts are being applied to majority of industries globally and locally. With high tendency of scarcity of people thinking about remedies for utilize natural resources efficiently.

As all other industries, construction industry also tries to adopt sustainable concepts for their building work. Considering the Sri Lankan approach regarding the sustainable concept is important. For that it is important to consider social, economic, cultural, and cost factors. A developing country like Sri Lanka should pay more attention to the cost factor.

The case study was conducted on the Sustainable Construction's Materials used in the project X. The collected data from the project were analyzed with the questionnaire answers (Qualitative) collected from the expertise on this field. The main objective of the research is based on the effective study of the contractor regarding the WLC of the sustainable components. It seemed through the construction documents the contractor didn't do any deep study regarding the selection of the components. The selection process only depends on the quality and the price based on the quotations.

The comparison of the Initial contract price and the contract price of the project shows a huge variation of the prices. The main factor for this variation is the sustainable construction. The contractor had to spend more money for the maintenance purpose than the anticipated amount during the construction and the defects liability period. The expertise people mention that the Lack of proficiency of the contractor is the main reason for this issue. The contractor statement mention that the reason is the Unavailability of resources.

The Technical factors were considered by the contractor on the performance assessments are aesthetics, Durability, cleaning Thermal properties, Acoustic properties. The contractor stated that due to the Unavailability of resources the performance assessment was not conducted in the expected level.

The WLC calculation and the performance assessment were again compared with the available alternatives in the local and the global market to give more emphasis for the findings and the recommendations. The findings of the research reveal that the main reasons for the research problem are Lack of proficiency, Unavailability of resources, Negative attitudes, Reluctance to move with new trends, economical factors and the performance factors. Based on that the recommendation was made to the Project X and for the Construction industry of Sri Lanka.

V. CONCLUSION AND RECOMMENDATION

If construction industries are actively engaging with sustainable concepts, they should thoroughly analyze the life cycle costing and the payback period of total cost. Then it will depict how worth it is and how nicely it manages the building's energy, water, air quality and site towards the betterment of organization. If buildings are integrating BIM to this process, all cost calculations can be done before the construction and that analysis will greatly support the decision-making process of the organization. Accordingly, it helps to implement sustainable building concepts along with sustainable building certifications.

According to the facts obtained through the literature review, most of the organization including sample organization, select sustainable building elements for their construction, not considering the whole life cost. If construction industry has sperate professionals for whole life cost estimation the accuracy of the whole life cost will be very high. Then most of the investors plan their budget with the help of a whole life cost estimator to minimize

their project cost. By that analysis building owners can get a basic idea about where and when to their monitory commitments to maintain, repair, and modify. Further, it is recommended that the government should encourage the law grade contractors to use sustainable elements after rational whole life cost analysis. It will cause to encourage sustainable material supplier and the prices of materials will be low. A whole life cost concept for sustainable buildings is a new concept for Sri Lanka therefore well-maintained records regarding costs for the maintenance and the repairs will be important. It will be important to analyze the way that investors should make their monetary commitments to maintenance and repairing of the building.

Implementing the green concept for buildings is practically possible for all building types. But due to the insufficiency of resources and competent personnel, this has become a sort of discussing matter. When it comes to the sustainable building concept, with the rating parameters we have to go for sustainable energy system, air quality system and water management system. So, in this scenario, the initial cost is relatively high. That means to cover this initial cost, the payback period is much higher. Hence, all these comprehensive procedures are hesitant to take the step forward to move with the sustainable concept.

So, if we go for sustainability considering global environmental constrains it is worthless. Most of modern thinkers, think like in this regard. But according to our opinion, government should encourage investors to invest their money on sustainable construction because if we don't even start to make sustainable buildings we won't be able to compete with the global construction industry in the near future. Because globally there is higher market for the sustainable construction. Even if we have built sustainable building before achieving national development goals, when we achieve those goals we can maintain our national development with those type of construction which are globally accepted. Also, if we think beyond the cost constrains we can find out that the sustainability will cause to increase the popularity of tradename of the organization. More nature lovers will be attracted to the organization and it will be a long term benefit.

The contractor of the project is from China and also the technical people and other labors involved with the project are Chinese. The main limitation occurred during the case study was regarding the communication and the document clarification.

The research was conducted regarding a performance assessment and a Whole Life Cost analysis on sustainable construction elements of ABC green University. The data was collected via case study method and interviews of technical people who involve in the project and expertise people in construction industry related to WLC and sustainable construction. Through those data collecting methods, maintenance and replacement cost of WLC regarding sustainable components, economic and technical factors that affect to the WLC, identification of alternative materials for reduce WLC were the objectives. By analyzing those objectives, the lack of knowledge regarding WLS methods and procedures of stakeholders in the industry, the necessity of WLC in the preliminary stage of the construction project has been identified and finally, the benefits of sustainable construction with proper analysis of WLC for construction project as a country has been identified.

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