Developing a Research Methodology for Life Cycle Costing Framework for Application in Green Projects

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Abstract. Life cycle costing (LCC) is a method of accessing the total cost of ownership and has been used around the world for the last few decades. Even though many benefits have been associated with LCC, one of them being an effective tool for decision making, its implementation in construction industry is still limited, particularly in green projects. Among the main factors suggested to have hindered application of LCC are lack of knowledge and understanding on LCC, as well as absence of a standard guideline. This paper presents a research methodology adopted for a research aimed to develop a life cycle costing framework for its application in green projects. The objectives are to investigate the current practice for LCC application in Green projects, and to determine the relationship between LCC principles with factors influencing effective decision making for LCC best practice in Green project. The methodology of the research involves qualitative and quantitative method, and will be validated by an expert panel interview. The paper provides an overview on the research area, particularly to highlight the issue on the application of LCC and its importance to assist decision makers.

1. Introduction

Life Cycle Costing (LCC) has been commonly allude to in sustainable-related studies. Within the context of built environment, life cycle costing is a method used to assess the anticipated economic performance of a building throughout its life cycle which includes: design and construction, operation and maintenance, in addition to disposal [6]. LCC applications in green building have been increasing since sustainable building became prominent at the beginning of 21st century. Through the assessment process of LCC, project stakeholders would be informed of the financial and non-financial gains of environmental and social sustainability initiatives [34]. LCC, has also been associated with green procurement, a procuring process that seek to source goods, services or work with a reduced environmental impact, or in other words, environmentally friendly [13]. In Malaysia’s own Government Green Procurement (GGP), LCC has been hailed as an important instrument to support its implementation, and can be considered as one of the awarding criteria for decision making [21]. This paper is part of an on-going research to develop a life cycle costing framework for its application in green projects. The aim of this paper is to provide an overview on the area of study and to describe the methodology intended to be used by the author to accomplish the research aim.

2. Problem Statement

Quite a number of researches has been done on LCC applications in green building across the world, varying in terms of area of interest. However, there appeared to be a general lack of acceptance of LCC
method in the construction industry practices [18] and [33]. Furthermore, [14] believed that not much attention is being given to the real implementation of LCC by the public sector. Therefore, there is a need to investigate to what extent has the Malaysian construction industry applied LCC, particularly in Green projects, including the problems and issues in such application.

Various studies claimed LCC can give great benefits to a development through its application either in conventional projects or even in green projects. Moreover, researchers have specified the important role LCC plays in decision making [27] and [7]. It has also been described as a tool for the comparison and optimization of building solutions [8]. So how does LCC contributes to effective decision making, particularly in Green projects? Understanding on the relationship between LCC and successful decision making is necessary for formulating proper strategies to implement LCC in Green projects. This study will help stakeholders and project team to understand better the advantages gained from the application of LCC in Green projects.

One of the barriers in implementing LCC in construction industry is the lack of knowledge of clients on LCC [24]. The study further listed lack of training on standardized LCC approaches and guidelines is also another problem that limits the use of LCC in the industry. Lack of understanding of the LCC techniques and the absence of a standardized guideline as among the key barriers to wider implementation of LCC [30]. Hence, a guideline or framework is needed to provide clear implementation of LCC in the Malaysian construction industry, particularly for green projects. The findings of this study will not only contribute to filling the gap in knowledge concerning LCC application in Green projects, but also provide valuable reference for stakeholders, project team, and others. Therefore, the aim of this research is to develop a procedural framework for the construction industry practitioners to improve the application of LCC towards effective decision making for Green Project in Malaysia.

3. Literature Review

3.1. The Concept of LCC

The history of LCC can be traced back in the mid-1960s, where the US Department of Defence applied in their procurement technique [2]. Over the years, the application of LCC has expanded to many areas such as product design, buildings, transportation, and technologies [12] and [28]. The term ‘life cycle costing’ is used interchangeably with other terms such as ‘life cycle cost analysis’, ‘whole life cost’, and ‘total cost assessment’ [35] and [26]. As useful as any, LCC can be defined as “a process to determine the sum of all expenses associated with a product or project, including acquisition, installation, operation, maintenance, refurbishment, discarding, and disposal costs” [37]. A building’s economic performance throughout its life cycle, starting with its initial planning and design to construction, operation and maintenance, refurbishment and finally, its demolition, can be evaluated by using LCC [39]. [4] stated LCC consists simple tree of acquisition cost and sustaining cost of the acquisition during its life. On the other hand, the LCC model developed by the Society of Automobile Engineers (SAE), breaks down the costs into five (5) elements which are acquisition cost, operating cost, scheduled maintenance cost, unscheduled maintenance cost, and conversion cost or decommission costs [31].

3.2. LCC Application in Construction Industry

It has been suggested that if properly carried out, LCC will deliver benefits such as transparency of future cost of operations, improve ability to plan future expenditure, increase awareness of total cost improve ability to manipulate and optimise future costs at the design stage, higher chance to achieve and obtain better value for money (VFM) in project, provide competitive alternatives evaluation and better performance trade-offs against cost. However, there still appeared to be a general lack of acceptance of LCC method in the construction industry practices [18] and [33]. The availability and reliability of data such as lifespan, future costs of operation, maintenance, previous consumptions, fixed costs, and investments, is also one of the main challenges for the mainstreaming of the use of LCC [19]. While an investigation by [29] revealed that the key factors limiting wider application of LCC in the UK construction industry were lack of understanding on LCC techniques, absence of standardized guideline and lack of reliable data input for LCC calculations. Nonetheless, this does not mean that the
industry is not actively promoting LCC as a decision tool for the evaluation of environmental sustainability. Many initiatives have been taken by governments as well as practitioners around the world in the effort of encouraging the application of LCC [9].

3.3. LCC in Green projects
Over the years, studies exploring on environmental and economic analysis of products, technologies and systems has been increasing [38] and [20]. Increment in the research of LCC application in Green projects is also apparent, with variation in the area of interest. This is encouraging news as LCC has long been recognized as one of the foundations for achieving sustainability [16]. Quite a number of researches has been done on LCC applications in green building across the world. For example, [10] had envisaged more LCC applications to profile the performance of green project by assessing the costs and benefits in economic terms. While [32] applied whole-life costing to evaluate different environmentally friendly technological options that relate to construction and facilities management.

There were also studies carried out that attempted to combine the use of LCC with other methods such as Life Cycle Assessment (LCA) [17] and [27] and sensitivity analysis [40] and [23], in order to investigate the implications of critical input variables on LCC for making risk-informed investment decisions concerning the adoption of certain green components. Nonetheless, not many researches have been undertaken to examine LCC implementation in the green scene of Malaysian construction industry. The most current and relevant study was by [25], who attempted to identify the most eco-efficiency scenario in concrete waste management by using LCA modelling together with LCC. Another study carried out a review on the state of cost data inputs of LCC for rigid pavement maintenance and rehabilitation [1]. The research concluded that LCC practice in the relevant area was still at an infancy state due to the difficulties in obtaining quality cost data for a comprehensive and reliable LCC analysis.

[15] emphasized that making environmental decisions is complex and decision makers need practical tools to help them learn about the choices available before deciding on the best sustainable option. [5] highlighted the need to influence critical decisions related to construction and operating costs can be done by applying LCC in the early stages of design process. Apart from that, it was suggested that LCC combined with LCA makes up a valuable tool for decision-makers [7]. [27] stated that a combined-integrated analysis can provide decision makers with a balance set of information to consider both the environment and economy, which is necessary for any green development. He further added that LCC provides vital economic information which help decision-makers fully understand the full costs and benefits involved in the short to long term.

4. Research Methodology
This paper is part of an on-going research to develop a life cycle costing framework for its’ application in green projects. Accordingly, the methodology framework proposed for this study will be a mixed-method approach divided into the following four (4) stages:

4.1. Literature Review
The first stage encompasses gathering of relevant literatures from existing publication to be obtained from databases pertaining to scientific and technical research that provides research papers in the area of built environment. The preliminary study will help to identify specific issues and problems in relation to the topic and becomes the basis for extensive literature review and fine tuning for the study. The literature review involves comprehensive understanding on the current state of LCC applied in green projects. The analysis will involve making summary, classification, and comparison of prior research studies.

4.2. Questionnaire Survey
The type of sequential explanatory design of mixed method [11] will be utilised for the research. Hence, a quantitative study will be used to obtain data on the current practice in the use of LCC in green projects including the problems and issues in its application. The data will be gathered through distribution of a set of closed-ended questionnaires to professionals who have been involved in green projects. Respondents from about 300 projects that have been rated green by recognised Malaysia’s green rating
tool will be identified and gathered. The sample size will depend on the number of projects that have received green certification but will be based on the principle formulated by [22]. Analysis of the data will use SPSS software due to author’s familiarity with the software. From the responses, conclusions will be made as to whether or not LCC is frequently applied in green projects, and in cases where LCC was applied, to what extent of its application and whether or not such application had contributed to effective decision making throughout the projects’ execution.

4.3. Interview
As mentioned earlier, the research will adopt sequential exploratory method. Thus the next stage is qualitative method of in-depth interview with the purpose of validating data obtained from the quantitative method. The semi-structured interview is meant to get in-depth information in relation to LCC application, the problems and issues, and to understand how LCC had contributed to effective decision making throughout the green projects’ execution. From the questionnaire survey, respondents who have been involved in green projects that have applied LCC in any phase of its life cycle, and possess practicing experience of 10 years and more, will be selected as the respondents for the interview session. Generally, at least 5-16 participants will be selected in order allow for a timely intensive analysis for each case to be conducted [36]. The data interpreted by means of content analysis method will then be analysed using Atlas.ti software due to the author’s familiarity with this tool.

4.4. Expert Panel
Subsequently, data gathered from both quantitative and qualitative method will be translated into an appropriate framework and will be forwarded to expert panel interview in order to validate the final findings of the framework. Expert panel interviews will complete the triangulation approach to be adopted in this research, which makes the data more reliable and robust. At least 5 experts will be identified for this purpose [3]. Apart from reviewing the findings, the experts will also evaluate the significance of the issues identified from the previous data collection. Once the significance of the findings is validated by the experts, the issues can be properly evaluated based on the expert’s evaluation. From here, the framework will be finalized. This framework can act as a reference for the industry and stakeholders and help to improve their understanding on the best approach in implementing LCC in Green projects.

Figure 1: Research methodology framework
5. Conclusion
As a conclusion, it could be summarized that the application of LCC in practice is still limited, especially in green projects, although research trends are increasing in this area. Both public and private sectors are still wedged to the traditional approach of project development, looking towards short term initial cost, rather than the best long-term value. Besides, there is still much work to be done in justifying the need for a conscious shift of focus towards implementing LCC in green projects. This should start by focusing on the clients, who as decision makers play a key role in advocating LCC. Hence, it is crucial for the clients to understand how LCC contributes to making decision effectively. Apart from that, the research aims to develop a life cycle costing framework for its’ application in green projects. By adopting the approach discussed in the research methodology section, it is hope that such framework can be established for the construction industry practitioners to improve the application of Life Cycle Costing towards effective decision making for Green Project in Malaysia.

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