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Integrating Environmental Costs Into Asset Life Cycle Costing and Acquisition Strategy

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Abstract: The purpose of this paper is to illustrate how environmental costs should be integrated into the LCC as an asset costing and acquisition strategy for the firm and the importance thereof. This paper suggests the integration of environmental costs into life cycle costing (LCC) as an asset costing and acquisition strategy for the firm. This paper argues that effective LCC and life cycle assessment (LCA) are fundamental to the attainment of the firm's long-term goals and enhances organisational performance. The method applied in this paper is a normative research approach, where the researcher has presented and illustrated the existing life cycle costing approach and illustrated further how environmental costs can be integrated to broaden the cost base to include environmental considerations. This paper intended to fill gap in the body of knowledge. Therefore, decision-makers, policy-makers and academicians could find this content of this paper valuable. This paper presents a Life Cycle Cost Assessment Framework. The importance of this integration is also highlighted in the paper. In conclusion, the paper recommends that firms should administer and control their environmental issues and costs to improve performance.

Keywords: Life cycle costing; Environmental costs; Asset costing; Acquisition strategy; Firm performance

JEL Classification: H23

1. Introduction

Life Cycle Costing (LCC) has been established as a mechanism to help asset managers in decision-making processes and to accomplish an assessment of the life cycle costs of selected assets of the firm (De Luca, Molari, Seddaiu, Toscano, Bombino, Ledda, Milani, & Vittuari, 2015). LCC as a tool enables managers and consumers to make better decisions regarding the acquisition of assets and a continuous utilisation of those assets of the firm. In addition, LCC as a tool is effective for appraising the assets investment of the firm (Iotti & Bonazzi, 2014). LCC is defined in the literature as the procedure followed in recognising and recording the overall costs entailed over the life of an asset of the firm (Bierer, Götze, Meynerts & Sygulla, 2015). The purpose of this paper is to illustrate how environmental costs should be integrated into the LCC as an asset costing and acquisition strategy of the firm and the importance thereof.

Consequently, the contemplation of various costs (both direct and indirect costs) over the entire life of a firm's asset provide a comprehensive basis for quality decision-making process (Heijungs, Settanni

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& Guinée, 2013), and as such managers may find it beneficial to implement those decisions (Kurczewski, 2014). The LCC as a process can be simple because the anticipated yearly costs associated with the assets enable the formation of decisions based on the expectations of imminent cost drivers (Bierer et al., 2015). In addition, the extent of LCC assessment deal with the challenges associated with the assets under consideration. This includes the capability to foresee future costs and the importance of those costs in the firm's decision-making process (Wang, Zhai, Li, Ni & Guo, 2015). LCC and life cycle assessment (LCA) are both pivotal approaches that involves the life cycle-related economic and environmental decision-making of the firm (Bierer et al., 2015). Further, LCA can be employed to assess the environmental effect of commodities, that is, input, processes and output linked to the production of those commodities and its life cycle (Elomaa, Sinisalo, Rintala, Aromaa & Lundström, 2019). LCA is fundamentally an environmental technique useful to assess environmental effect during production processes. However, the consideration of recycling waste products as an environmental effect may improve the health of the citizens and hence sustainability (Dhaliwal, Browne, Flanagan, Laurin & Hamilton, 2014).

Moorthy and Yacob (2013) focused their study on green accounting as the portion of the environmental responsibility. The authors (2013) state that the green accounting systems consists of the multiple objectives of administering and enhancing the economic and environmental operations of the firm. Furthermore, this article highlights the issues associated with the financial reporting of costs relating to the environment and its impact on the society.

The research aim of this paper has been to illustrate how environmental costs should be integrated into the LCC as an asset costing and acquisition strategy of the firm and the importance thereof. The next section discusses the literature review pertaining to LCC and LCA and their integrations into environmental costs, followed by the research methodology employed in this paper. Finally, the paper culminates with the conclusion.

2. Literature Review

This section reveals a great deal of literature relating to life cycle costing (LCC) as an asset costing and acquisition strategy. As highlighted above, the purpose of this paper is to illustrate how environmental costs should be integrated into the LCC as an asset costing and acquisition strategy of the firm and the importance thereof. The following subheading are discussed: the background of the LCC and life cycle assessment (LCA); the role of LCC as an asset costing and acquisition strategy; and the effect of LCC and LCA on firm performance.

2.1. Background of Life Cycle Costing and Life Cycle Assessment

The research findings reveal that there is a necessity for more systematic support for mixed life cycle costing (LCC) and life cycle assessment (LCA) studies (Bierer et al., 2015). However, LCA had been broadly applied since its establishment in the early 1960s by various firms with a view to appraising the environmental effects on the citizens (Ghimire, Johnston, Ingwersen & Sojka, 2017). On the other hand, LCC has been regarded as a project which takes into account all the activities that are undertaken in a project, that is, it ranges from "identification of a need for implementing a project to the project completion in a form of disassembly or disposal" (Kozarkiewicz & Lada, 2014, p. 187). Therefore, the major distinction between LCC and LCA is that the former focuses on the economic

issues of the firm and the latter on the environmental impacts on the society (Kurczewski, 2014; De Luca, Molari, Seddaiu, Toscano, Bombino, Ledda, Milani & Vittuari, 2015; Elomaa et al., 2019).

The LCC and LCA are thus intertwined. The LCA involves the assessment as a measure of the performance of assets of the firm. Although the LCC and LCA are performed independently with unique objectives, both are applied concurrently in the firm setting (De Luca et al., 2015). As highlighted above, the LCC as a tool deal with the management of economic issues of the firm. On the other hand, the LCA focus on the effects of the assessment. This includes amongst others, classifying the resources, considering the health of citizens and taking care of the environment (Dhaliwal et al., 2014; Elomaa et al., 2019). The LCC and LCA are often applied in the dynamic of life cycle-broad assessment and consider the similar kind of items (such as products, resources and processes). They are however, employed autonomously (Heijungs et al., 2013).

The LCC can be applied either on a single product component or a certain number of products components (Bierer et al., 2015). The LCC has been viewed as an approach that intends to measure the absorption of scarce resources into the manufacturing process of firm's products (Iotti & Bonazzi, 2014). In contrast, LCA is normally contemplated and recognised as having only one product component (Dhaliwal et al., 2014). Therefore, it enables managers to expedite quality decision-making process pertaining to new product design, purchase of equipment and capital apportionment (Kurczewski, 2014). It is from this vantage point that this paper sought to illustrate how environmental costs should be integrated into the LCC as an asset costing and acquisition strategy of the firm and the importance thereof.

2.2. The Role of Life Cycle Costing as an Asset Costing and Acquisition Strategy

LCC refers to the "cost management method for the evaluation of all economic consequences (e.g., costs, revenues, cash flows) and monetary trade-offs occurring in an object's life cycle" (Bierer et al., 2015, p. 1289). The costs associated with LCC are the total costs of all the activities accomplished by the firm and this includes, amongst others, the supply of components and disposal of packaging (Kozarkiewicz & Lada, 2014). The LCC is a useful technique for improving the capital investments of assets of the firm (Iotti & Bonazzi, 2014). There are different factors that contribute to a rise in the application of evaluation tools that focus on the life cycle concept (Kurczewski, 2014). These include:

- the methods to diminish the costs associated with running the business;
- innovative solutions with prospects of improving market position; and
- the firm's capability to conform with all applicable legislation and ethical criteria, essentially in the area of environmental impact and sustainability.

Generally, the LCC and LCA are most commonly used methods related to the issues associated with the environmental and economic decision-making processes of the firm (Heijungs et al., 2013; Bierer et al., 2015). In addition, the life cycle thinking has been mostly applied in various firms (Padilla-Rivera, Morgan-Sagastume, & Güereca-Hernández, 2019). It assists managers in establishing a thorough analysis of the triple bottom line factors of the firm such as environmental effects, communal consequences and economic costs (Toosi, Balador, Gjerde & Vakili-Ardebili, 2018; Kurczewski, 2014; Basbagill, Flager, Lepech & Fischer, 2013). Most importantly, life cycle thinking has been pertinent for choosing superior technological innovations, taking into cognisance those external conditions such as economic, social, ecological and technological aspects (Padilla-Rivera et al., 2019).

A research by Kozarkiewicz and Lada (2014) argues that "the life cycle costing is an exemplary tool of strategic project management accounting which develops the scope of analysis and cost measurement outside the frames of organisation realising the project: depending on the adopted perspective of making such costing it includes costs incurred by manufacturers of materials or subassemblies, or costs incurred by customers due to the purchase, utilisation and disposal of project's product" (p. 188). There are various complexity-related factors that contribute to the life cycle costing as an asset costing and acquisition strategy of the firm (Heijungs et al., 2013). Amongst others, these are: price inhomogeneity; the cost of environmental services; costs of utility services; non-final-use products and discounting.

2.3. The Effect of Life Cycle Costing and Life Cycle Assessment on Firm Performance

The systematic employment of the LCC and LCA serve as a mechanism for regulating a firm's performance such as the ability to examine environmental and economic success or failure (Bierer et al., 2015; Wang et al., 2015). The main objectives of the LCA include diminished effects on the well-being of the citizen while ensuring economic sustainability and thus enhanced firm performance (Ghimire et al., 2017). An appropriate application of the LCC had enabled firms to increase investments, and ensuring enhanced business efficiency and decreased manufacturing costs. This leads to maximisation of firm profitability and performance (Iotti & Bonazzi, 2014). The LCC has been regarded as a valuable and systematic technique for the inception and management of the investments.

The establishment and proper execution of suitable accounting systems such as a green accounting system as it involves LCC, may improve the economic and environmental performance of the firm (Moorthy & Yacob, 2013). Furthermore, the appropriate use of the performance measurement approach such as the balanced scorecard, would ensure the stability between the short-term and strategic decision-making of the firm (Iotti & Bonazzi, 2014). Therefore, balanced scorecard involves the measurement of perspectives such as customer, finance, internal business processes and learning.

Several studies have been conducted in the subject of LCC and LCA and their impact on the firm's performance and society at large. Basbagill et al. (2013) investigated the application of LCA and its environmental impact performance on the early-stage design of the building's project to reduce the embodied carbon footprint and emissions. The study presented various techniques for implementing the LCA as an enabler for decision-makers to consider the environmental impact performance of the building's project at the design stage. The findings reveal that the techniques can be useful to help in the process of building design by pinpointing the prominent alerts that are pivotal to the reduction of environmental costs and thus, impacts to the citizens.

Another study conducted by Ito, Yamanaka, Nehashi, Fukuda and Minegishi (2015) examined the comparative assessment of three embankment techniques that are effective for a road construction project in Japan. The study intended to employ the LCA to forecast the entire emissions of carbon dioxide (CO2), nitrogen oxide (NOx) and sulphur oxide (SOx) along with the LCC of the project. The study suggests that the establishment of an effective manufacturing systems could play a substantial role in the reduction of carbon dioxide emissions, LCC and other means of pollution. The study recommends that recycling of the waste products could lead to enhanced environmental sustainability and reduced environmental impact to the society.

Toosi et al. (2018) examined a LCC assessment and environmental analysis of photovoltaic systems and technologies in buildings in Iran. The results of the study show that the use of photovoltaic systems yielded limited environmental impacts as compared to the traditional power generating

factories. The study suggests that government funding and awareness programmes should be implemented to inspire the public to use the photovoltaic systems and which would diminish the potential environmental costs.

Padilla-Rivera et al. (2019) conducted their study on the challenges with regard to water treatment and the sustainability evaluation of wastewater using an environmental and economic approach. In their study, the LCA methodology was employed to appraise the sustainability of wastewater as a solution to the environmental dilemma facing the society. The researchers suggest that between the two approaches, the environmental sustainability model could primarily be employed to enable decision-makers to contemplate the environmental costs before reporting.

3. Research Methodology

This paper adopts a normative research approach. A normative approach attempts to suggest and/or prescribe how a certain activity should be done to enhance improvement in a particular business process (Zinn & McDonald, 2018). More than ever, policy evaluations are becoming increasingly complex given the multifarious nature of the current business environment (Glenn, 1994), which is orchestrated by the twin force of globalisation and the environmental movement of the 21st century. Since physical assets represent the fulcrum of every business, it becomes important to provide the effective and efficient monitoring of assets from acquisition to disposal (Woodward, 1997). This is because an accurate life cycle costing improves business value by avoiding any understatement of costs. This paper suggests an improvement in conventional life costing in that it prescribes that life circle costing should integrate environmental costs during life cycle cost assessment in order to present a better view of what it may cost the firm to acquire an asset up to the point of the disposal of such an asset. This approach thus relies on the normative research approach, which describes the current state of things but proceeds to advocate improvement on it (Smith, 2019). Therefore, the following section provides a hypothetical company illustration of author's suggested integration of environmental costs to life cycle costing.

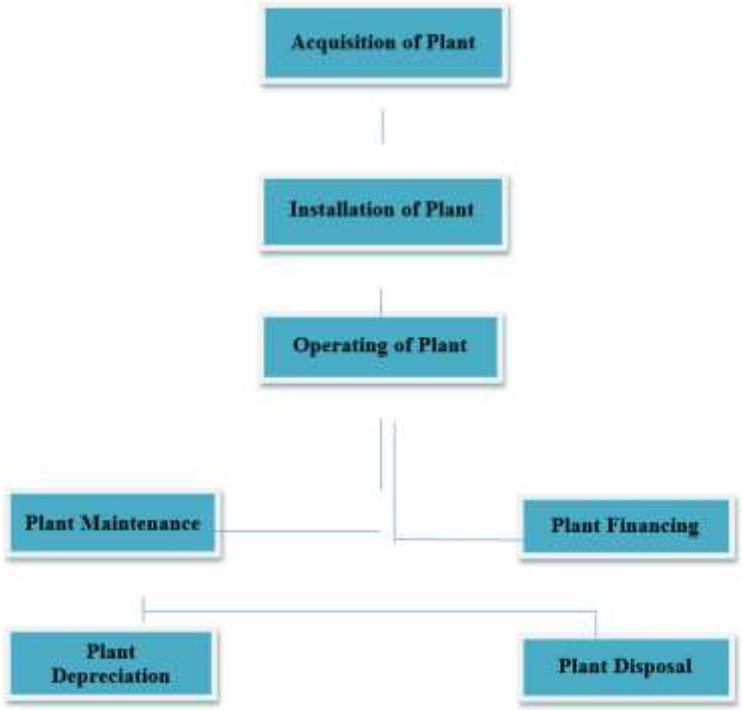

Figure 1. Life Cycle Cost Assessment Framework
Source: Author

Hardware Company PTY

Table 1. Estimated Life Cycle Cost Assessment of Plant Acquisition and Disposal

Plant Life Cycle State	**Estimated Amount**
Plant Acquisition	R2 000 000
Plant Installation	R10 000
Plant Operating Costs	Variable Costs (whole life): R10 000 Fixed Costs (whole life): R50 000
Plant Financing (as per interest rate of 1% per month). To complete capital payment in one year (12months)	Total finance charge for 12 months = R2 000 000 x 0.01 = R20 000 x 12 = R240 000
Plant Depreciation per annum	R200 000
Plant Disposal cost by a contractor	R10 000
Estimated total plant life	10 years

Table 2. Estimated Life Cycle Cost of Plant Acquisition and Disposal

Plant Life Cycle State	**Estimated Amount**
Plant Acquisition	R2 000 000
Plant Installation	R10 000
Plant Operating Costs	R60 000
Plant Financing (as per interest rate of 1% per month). To complete capital payment in one year (12months)	R 240 000
Plant disposal cost by a contractor	R10 000
Total Life Cycle Cost of Plant	**R2 320 000**

Note: that the depreciation cost has already been taken care of since, after ten years, it is equal to the amount used in purchasing the plant (it is not a physical cost outlay, but the written down value of the plant each year).

From the above life cycle cost, it can be seen that, whilst the total initial cost of plant acquisition is R2 000 000, the total life cycle cost will amount to R2 320 000 at the end of the plant's life after ten years. The above process represents the conventional life cycle costing approach. However, this paper recommends the inclusion of estimated environmental costs along the life cycle. For instance, the consignee (being the Hardware Company PTY) may be responsible for the emission tax based on the emission level of the plant (payable after the environmental department inspection on after installation of plant). Environmental tax on plant disposal. These should be added to the conventional assessment conducted above. Therefore, Table 1 above will be readjusted as shown in Table 3 below:

Table 3. Estimated Life Cycle Cost Assessment of Plant Acquisition and Disposal

Plant Life Cycle State	**Estimated Amount**
Plant Acquisition	R2 000 000
Plant Installation	R10 000 Plus national emission tax: R15 000
Plant Operating Costs	Variable Costs (whole life): R10 000 Fixed Costs (whole life): R50 000
Plant Financing (as per interest rate of 1% per month). To complete capital payment in one year (12 months)	Total finance charge for 12 months = R2 000 000 x 0.01 = R20 000 x 12 = R240 000
Plant Depreciation per annum	R200 000
Plant Disposal cost by a contractor Environmental tax on plant disposal	R10 000 R20 000

From the above Table 3, the new total life cycle cost after integrating environmental costs will increase from R2 320 000 to R2 355 000 (R2 320 000 + R35 000). The implication of not including the above environmental costs in the asset's life cycle cost would include the understatement of budgeted costs and understatement of budgeted sales price of the company. It would also affect company's readiness to prepare for managing these environmental costs, and failure to manage the environmental costs would likely increase the normal environmental costs above, as a result of non-compliance. This paper has, therefore, made a contribution to the existing literature by integrating environmental cost considerations into the conventional life cycle costing.

4. Conclusion

This paper has intended to examine the importance of life cycle costing (LCC) as an asset costing and acquisition strategy of the firm and to illustrate the integration of environmental costs into the conventional life cycle cost assessment. The paper has explored more on the LCC and life cycle assessment (LCA) as techniques that are effective for resolving challenges associated with the environmental issues and performance. Therefore, the environmental costs associated with LCC were discussed. Literature revealed that LCC play a significant role in the firm setting by ensuring the environmental and economic viability of the firm and thus enhance the performance. Alternatively, the LCA benefits the firm. The complexity-related factors that contribute to the LCC as an asset costing and acquisition strategy of the firm were also discussed. The incorporation of environmental costs into LCC and LCA would generate better results and superior performance, stemming from the consideration of economic and environmental impacts. In addition, the successful integration of

environmental costs thereof, would effectively complement the establishment of the life cycle sustainability evaluation of the firm (Heijungs et al., 2013).

This paper suggests that the proper implementations of the elements of green accounting in the firm, which include environmental and economy factors, are essential and thus enable the firm to analyse its external variables efficiently and effectively (Moorthy & Yacob, 2013). In addition, the decisive approach to environmental and economic issues could contribute to the improvement of the firm performance and hence, competitive edge market. Lastly, a dynamic administration and control of the environmental issues may lead to a decrease in environmental costs to the firm which would accordingly increase profitability and wealth of the firm.

This paper has sought to illustrate how environmental costs should be integrated into the LCC as an asset costing and acquisition strategy of the firm and the importance thereof. Therefore, future research is required to assess the life cycle cost of assets quantitatively and its environmental costs emanating from the production processes of the commodities (such as carbon footprint, emissions, waste and pollution) of firms which are listed in the Security (Stock) Exchange.

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