# "Using Life Cycle Costing approach For Enhancing Sustainability In The Light Of Value Chain Requirements"

## Extract from a PhD thesis entitled

## "Using material flow cost accounting approach for numerical control on the product life cycle costs to enhance sustainability in the light of value chain requirements"


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**ملخص:**

تهدف الدراسة الي استخدام نظام تكلفة دورة حياة المنتج بغرض تعزيز الاستدامة البيئية والإقتصادية للشركات الصناعية في ضوء متطلبات سلسلة القيمة،وتوصلت الدراسة من خلال إجراء دراسة ميدانية الي أن نظام تكلفة دورة حياة المنتج يساعد في تخفيض التكاليف خلال كافة مراحل دورة حياة المنتج وتحديد العوائد المتوقعة من خلال اختيار أفضل البدائل وإدارة الموارد بشكل أكثر كفاءة والمساعدة علي اتخاذ القرارات الإدارية السليمة، مما ينعكس علي الاداء البيئ والإقتصادي للمنشأت الصناعية وتعزيز القدرة التنافسية لها. وتوصي الدراسة بضرورة تطبيق نظام تكلفة دورة حياة المنتج، ضرورة دراسة وتحليل العلاقة التكاملية بين المداخل الحديثة الأخرى لإدارة التكلفة ومحاولة الاستفادة منها في دعم القدرة تنافسية للمنشآت لتحقيق الإستدامة البيئة والاقتصادية مثل محاسبة تكاليف تدفق المواد ، بطاقة الأداء المتوازن.

**الكلمات المفتاحية: تكلفة دورة حياة المنتج_ الإستدامة_سلسلة القيمة**

## Abstract

The study aims to use the product life cycle cost system in order to enhance the environmental and economic sustainability of industrial companies in light of the requirements of the value chain. The study conducting through the empirical study that the product life cycle cost system helps reduce costs during all stages of the product life cycle and determine the expected returns by choosing By choosing the best alternatives, managing resources more efficiently and helping to make sound administrative decisions, which is reflected on the environmental and economic performance of industrial facilities and enhances their competitiveness. The study recommends the need to implement the product life cycle cost system, the need to study and analyze the integrative relationship between other modern approaches to cost management and try to benefit from them in supporting the competitive ability of enterprises to achieve environmental and economic sustainability such as accounting for material flow costs, the balanced performance card.

**Key words**: life cycle costing_ sustainability_ value chain.

# Introduction

Our consumption and production patterns impact our planet such that we are reaching the limits of growth with the planet being unable to indefinitely assimilate the effects of anthropic activities However, natural resources are vital to industrial production, without which value creation is impossible (Ramona,2018).

Nowadays, a modern, competitive and environmental concerned society are pressuring companies to achieve higher productivities with the lowest possible environmental impact Thus, few alternative methods have been emerging, to support management decisions in terms of economic performances and simultaneously consider the environmental impact and production volumes (cecilio,2017).

## 1/1 Research Problem

In these days, Life Cycle Costing is used widely in industries as decision-making tools or as management tools, the analyst should assure that the level of details integrated into LCC is sound with the level of investment decision under consideration. There comes a point of diminishing returns as more and more cost factors are incorporated into LCC, some studies discussed the relative influence of individual factors on the LCC analysis results may change from primary to minor to inconsequential. For example, minor differences in future costs have a significant effect on discounted present value. Including such factors as this will complicate the analysis without producing actual improvement in analysis outcomes. Including all factors in every analysis is frequently not progressive, in conducting an LCC, analysts should investigate all aspects of inclusion and clarify the motive for eliminating factors in simple terms, and LCC is an analysis technique that guides to better investment outcomes (Akbar and Mokhtar, 2017).

## 1/2 Research objective

The Study focuses on the development of a model through the using of life cycle costing in order to help in definition and specification the places of waste costs, which resultant from the waste and inefficiency usage for resources, and assist the management to make managerial decisions related with economics and environmental performance, and definition the opportunity of cost reducing and efficiency improvement over the product life cycle.

## 1/3 Research importance

The importance of research in the presence of a dearth of topics dealt with this problem and research through the study, which can be reached on the results benefit the community through the use of an objective in the environment of industrial.

Life cycle costing is one of the most crucial functions in decision-making during the early phase of a project's life-cycle, all decisions about the project and the implications for it require a range of stakeholders, including the owner, contractor, designer and lending company, They include economic analysis of a number of alternative project components, clarifying the feasibility of a project or identifying an initial cost of a project.

## 1/4 Research methods

The research used;

- **The deductive** approach through reviewing previous literature related to the research variable to benefit from them in achieving the research objectives.
- **The inductive approach** through carrying an applied study to test the research hypotheses.

## 1/5 Research question

Life cycle costing, a promising environmental management accounting tool, can help industrial companies improve their environmental and profitability performance?

## 1/6 Overview of Product Life Cycle Costing

The ability of a company to compete effectively on the increasingly competitive global market is influenced to a large extent by the cost as well as the quality of its products and the ability to bring products onto the market in a timely manner, It has been recognized that a life cycle engineering approach to the design of products has a great potential to achieve these goals (Asiedu and Gu, 1998).

Many traditional cost-accounting systems lead to incorrect investment decisions concerning environmental costs, one problem is for example that demolition and recycling costs appear outside the boundary of the traditional accounting system, A popular way of solving this problem has been to suggest the use of life cycle costing (LCC) which includes such costs (Gluch and Baumann, 2004). Life cycle costing is not a novel concept. In fact, it is known that over the years numerous life cycle cost

models have been developed, but no single life cycle cost model has been accepted as a standard model in the industrial sector (Bradley, et al, 2018).

## 1/6/1 Historical Background

There is no evidence of any LCC practice before 1847 when highway engineering economics was introduced to determine the most cost-effective and lowest construction and maintenance costs in the United States (Minja, 2014). The history of LCC can be traced back in the mid-1960s, where the US Department of Defense applied in their procurement technique (Maisham, et al, 2019).

Life-cycle costing was first used in the United States by the Department of Defense (US DoD) in the mid-1960's (Gluch and Baumann, 2003). The goal of lifecycle costing at that time was to assist the US DoD in the procurement of military equipment (Brindle, 2005).

In 1973, specific guidance concerning the use of the Life Cycle Cost Analysis concept in system acquisition was provided with the publication of the Life Cycle Cost Analysis guide for system acquisition, this document presents guidelines, including representative detailed procedures for applying of the Life Cycle Cost Analysis concept while getting of complete defense systems (Qabaja, 2017).

## 1/6/2 Theoretical Background

Cost accounting systems without a life-cycle perspective primarily focus on the manufacturing phase; however, LCC simultaneously considers costs that are generated prior to the production and after the sale of a product, Prior studies describe costs that are incurred during the earlier stages of the life cycle as typical life cycle costs from a firm's perspective (Knauer and Möslang, 2018).

This implies that the behavior of the 'economic man' in neoclassical economic theory is always rational. However, descriptive decision-making studies have shown that individuals do not make rational decisions, especially when uncertainty is involved because of complex and long-term consequences, which is typical for environmental decision-making. There are four inherent limitations in neoclassical economic theory that restricts its use in an environmental context (Gluch and Baumann, 2004):

• It cannot handle decision-making under genuine uncertainty since it assumes that the decision-maker is always rational and has access to complete information concerning alternatives and outcomes.

• It assumes that alternatives are always available. With such a view irreversible changes, such as extinction of species, are not considered as a problem since they can be 'replaced' without changing the ecosystem.

• It ignores items that have no owner, such as the natural environment.

• It over-simplifies multi-dimensional environmental problems since it assumes that everything can be expressed as a one-dimensional unit, such as monetary figures.

## 1/6/3 Definition of Product Life Cycle Costing

The goal of product life cycle costing is to take action and make decisions that promote the planning, marketing, distribution, operation, maintenance and disposal of a product in order to promote the long-term competitive advantage of the company concerned (Compt, 2009). LCC is distinctive because it focuses on a long-term, life-cycle perspective in cost accounting practices and counteracts management tendencies to focus on the short term (Knauer and Möslang, 2018).

According to (Zhang, et al, 2018) LCC could be defined as a tool which focuses on assessing all costs occurred during the lifecycle of a product, from conceptualization, manufacturing and operation to the end of its useful life also, As an extension of financial representation, LCC has a broad scope of integrated analysis comprising economic, environmental and social aspects, which denoted as Business/ Traditional LCC, Environmental LCC and Social LCC, respectively.

Also it could be defined as the concept of life cycle cost includes the total cost of the product from the early stages (development and manufacturing), mid stages (storage and transport) to the final stage where the product reaches the end-user. The life cycle costing is a management cost method which can be used for all sorts of products. However, the nature and objective of the analysis depends on the product itself (Khzouz, et al, 2019). LCC can be defined as an economic assessment technique that uses a mathematical method to estimate total ownership costs of an asset over its anticipated life and to determine the most cost-effective option among different competing alternatives (Jasmi, et al, 2018).

In this manner, (Heralova, 2019) state that Life cycle costing is a valuable technique that is used for predicting and assessing the cost performance of buildings, Life cycle costing is one form of analysis for determining whether a project meets the client´s performance requirements, Life cycle costs (LCC) mean involving all of the costs deriving from the

use of buildings during their entire life span also The LCC methodology is a tool for evaluating these costs over time. Its main goal is to assess the various tenders, where those tenders differ not only in their tender price but also in their operational and maintenance costs.

## 1/6/4 Factors That May Influence the Economic Feasibility of Applying Life Cycle Costing

Investigate the relevance of the cost structure to the extent of LCC adoption and consider R&D costs, guarantee and warranty costs, voluntary upfront and follow-up costs for ecological sustainability, along with the amount of precursors and intermediates that have been purchased. We expect R&D costs, guarantee and warranty costs and voluntary upfront and follow-up costs for ecological sustainability to be positively associated with the extent of LCC adoption because these costs are generated during the pre- or the after-market phases of a product or service (Knauer and Möslang, 2018).

The following factors that influence the economic feasibility of applying life cycle costing (Compt, 2009):

- Energy intensiveness. When energy costs are expected to be high throughout a commodity's life cycle, life cycle costing should be considered.
- Efficiency. When the efficiency of operation and maintenance cost has a significant impact on overall costs, life cycle costing will be beneficial when savings can be achieved to reduce these costs.
- Life expectancy. If a commodity has a long life, costs other than purchase costs are important.
- Investment cost. The larger the investments, the more significant life cycle cost analysis will become.

## 1/6/5 Benefits of Product Life Cycle Costing

We next discuss the benefits of LCC with regard to achieving cost-management goals. According to (Higham, et al, 2015 & Gluch and Baumann, 2004 & Knauer and Möslang, 2018 & Opoku, 2013 & Oduyemi, 2015 & Dunk, 2004) claimed that 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 as follows:

- Providing information on the different stages of the product's life cycle in a quantitative form so that the management can control the various activities of the product in these stages.
- It helps in evaluating performance for example, we find that determining maintenance costs enables the facility to identify the quality of the materials used in the manufacture of the product, as the increase in the number of maintenance times and the high costs of it may mean that the raw materials used in manufacturing are not good.
- Achieving the holistic dimension of cost measurement, which is one of the most important guarantees of accuracy and objectivity, and thus this method, avoids criticism of traditional cost systems, which focus on the costs of the production stage only despite the importance of pre- and post-production costs and their great impact on decisions related to the product.
- Determining the problems related to the product at any stage of its life cycle, So that corrective action can be taken in a timely manner.

Through the benefits and objectives that were presented, the researcher could conclude that, the product life cycle costing system helps the management to take all the correct procedures and decisions by providing information and alternatives that can be used during all stages of the life cycle of the product and the costs involved, including the pre- and post-production costs, which Contribute effectively to achieving sustainability for the facility and its products.

## 1/6/6 Barriers to Application of Product Life Cycle Costing

Despite the many benefits resulting from the use of the product life cycle costing system, there are many obstacles that limit the use of this method or the achievement of its benefit. According to (Alqahtani and Whyte, 2016 & Compt, 2009 & Higham, et al, 2015 & Kambanou, 2020 & Maisham, 2019 & Opoku, 2013 & Opawole, 2020) these obstacles could be concluded as follows:

- The need for accurate information to improve the result, seeming to be problematic when applied to the early stages of the asset life cycle because of a lack of information and inaccurate results especially when applied on a system level, a lack of predictive data.

- It is time-consuming to collect all the relevant data throughout the life cycle of the project.
- The accuracy of data is doubtful, the project life of a long-lived project.
- Is characterized by uncertainty - hence the difficulty of making economic Forecasts if the values of variable factors are unknown.
- The relevant costs are a combination of capital costs and running costs, these costs will be incurred at different times and cannot therefore being treated identically. Current and future costs should be presented in equivalent terms.
- The most commonly mentioned conditions that influence whether and how LCC is adopted are a lack of demand for LCC from the customer, understanding/awareness of LCC and its methods, and software.
- Organizational culture, the collective mind that distinguishes a group, to be the most relevant barrier for LCC use.
- Lack of understanding of the LCC techniques and the absence of a standardized guideline as among the key barriers to wider implementation of LCC.

Despite the many benefits resulting from the use of the product life cycle costing system, however, it is a time-consuming method. It is difficult to obtain data, and the accuracy of data is often doubtful because of the uncertainty of future forecasts. Fortunately, there is a solution to this problem. Risk and uncertainty can be analyzed to support effective uncertainty analyses and risk management; various life cycle costing models exist to assist with the difficulties. Some of the models will be briefly discussed below (Compt, 2009).

## 1/6/7 Phases of Product Life Cycle Costing

The life of a product can be divided into four major phases, namely introduction, growth, maturity and decline. Graphically, these phases can be depicted as follows:

### 1) The introduction phase

During the introduction phase, the product is developed and money is invested. Since no return can be expected during this phase, all investment is at risk and will be lost if development is not successfully completed (Compt, 2009). At this stage the gradual introduction of the

product into the market begins with, and the rate of sales growth at this stage is relatively slow, as the product is unknown to consumers, whether in terms of its characteristics, components, or degree of satisfaction. The stage is for consumers who have a desire to risk discovering new things (الفرماوي، 2011).

**2) The growth phase**

The product moves to the growth stage after its success in the presentation stage, where consumers begin to accept the products and learn about its characteristics and the degree of satisfaction of their needs, and sales of the product begin to increase at this stage at high rates (الفرماوي، 2011).

**3) The maturity phase**

According to (عطوة، 2020), The maturity stage is the longest stage among the stages of the product life cycle, as most products at this stage are at the end of their cycle and deal with this stage diligently and this stage are divided into a group of periods:

**First period:** stage of escalating maturity and in this period the growth rate in sales continues to increase due to the entry of some new segments of the consumer of the product, which increases the number of customers.

**Second period:** Stable maturity, Sales begin to stabilize as a result of saturation in the market of the product and there is no looming reason for increased demand as a result of stopping the entry of new customers.

**Third period:** Declining maturity, which is the stage of sloping maturity, and here sales begin to decline significantly due to intense competition in the market and the product's loss of its competitive advantages, and customers begin to gradually shift towards new forms of other represented products. So that the firm begins to work to maintain the growth of its sales of the product by:

- Improving the quality of the product.
- Adding new features.
- Making an adjustment in product form.
- Reducing the price of the product.
- Enhancing efforts in promotion, advertising and marketing activities.

**4) The decline phase**

The need to produce new products begins after the market is saturated with the product, where there is a desire of consumers for the product to buy products with the characteristics and capabilities of the current product; this is in order to satisfy their renewable needs and desires. At this stage, the product is withdrawn from the market until new products are introduced, but the organization maintains its position and works to keep pace with the renewable needs of its customers, this stage also includes a significant reduction in the selling price of the product, so that the organization can dispose of its remaining quantities of the product at any price (الفرماوي، 2011).

## 1/6/8 Elements of Product Life Cycle Cost

The LCC assessment includes the costs of the studied product asset from its primary investment cost to its end of life cost; however, the costs that must be included in the Life Cycle Costing study are different from one standard to another as they differ between countries and projects, As well, the cost breakdown structure included differing according to the nature of the study, The level of the cost breakdown depends on the field and the aim of the LCC study (Qabaja, 2017).

Product life cycle cost should take into account the following cost elements during the product life cycle (Asiedu and Gu, 1998):

**1) Production and construction cost**

The cost in this phase consists of things such as manufacturing (fabrication, assembly and test), facility construction, process development, production operations, quality control, and initial logistic support requirements (initial consumer support, the manufacture of spare parts, the production of test and support equipment).

**2) Operation and support cost**

The cost at this stage comprises consumer or user operations of the product in the product distribution (marketing and sales, transportation and traffic management, and sustaining maintenance and logistic support throughout the system or product life cycle (customer service, maintenance activities, supply support, test and support equipment, transportation and handling, technical data, facilities, system modifications).

### 3) Retirement and disposal cost

Development, use and retirement of products require the use and conversion of material and energy resources, because energy consumption, air pollution and waste management currently dominate public discussions and will continue to do so in the future, environmentally clean products and manufacturing technologies will have to be developed by companies who want to be able to compete, In addition, impacts caused by product usage and disposal are difficult to assess quantitatively since they depend on factors that are difficult to predict or anticipate.

## 1/7 Constructing empirical study

This section is concerned with an empirical study that focuses on testing the validity of using life cycle costing, a promising environmental management accounting tool, which can help industrial companies improve their environmental and profitability performance.

Research hypothesis shall be evaluated through survey study applied using Statistical Package for the Social Sciences program (SPSS) to analyze the data gathered about the sample as to decide whether to accept or reject the hypothesis.

The first part of this section discusses the construction of the empirical study and then the section provides a descriptive statistics of the survey study, the third part discusses One Sample T-Test in order to confirm the validity of using life cycle costing, a promising environmental management accounting tool, on enhancing companies sustainability through improving their environmental and profitability performance.

## 1/7/1 Sample of the study

The researcher had taken a random sample of academicians who had accepted to cooperate with the researcher and to answer the questions of the survey in order to get reliable information about the credibility of the using life cycle costing on enhancing companies sustainability. the researcher distributed 100 surveys to academicians and collected 69 answered surveys with a response rate of 69%.

- **Experience**:

**Table (1/1) Frequency distribution of the variable Experience**

| Expert | | | | | |
|---|---|---|---|---|---|
| **Serial** | **Item** | **Frequency** | **Percent** | **Valid Percent** | **Cumulative Percent** |
| **1** | **Less than 5 year** | 11 | 15.9 | 15.9 | 15.9 |
| **2** | **From 5-10 years** | 25 | 36.2 | 36.2 | 52.2 |
| **3** | **From 11-15 years** | 22 | 31.9 | 31.9 | 84.1 |
| **4** | **More than 15 years** | 11 | 15.9 | 15.9 | 100.0 |
| **5** | **Total** | **69** | **100.0** | **100.0** | |

**From the above table it is clear:**

A sample study according to the variable of " Experience " that most of the respondents in the category group (from 5-10 years) which accounted for a percentage (36.2%), came in the first place, then category group (From 11-15 years) which accounted for present (31.9%), and finally the category group (less than 5 year), (More than 15 years) by present (15.9%), According to the responses of the sample, implying that the majority of the sample is the category group (from 5-10 10 years), this category is considered to be of high experience.

- **Education:**

**Table (1/2) Frequency distribution of the variable Education**

| Education | | | | | |
|---|---|---|---|---|---|
| **Serial** | **Item** | **Frequency** | **Percent** | **Valid Percent** | **Cumulative Percent** |
| **1** | **BA** | 19 | 27.5 | 27.5 | 27.5 |
| **2** | **M.A** | 21 | 30.4 | 30.4 | 58.0 |
| **3** | **PH.D** | 29 | 42.0 | 42.0 | 100.0 |
| **5** | **Total** | **69** | **100.0** | **100.0** | |

**From the above table it is clear:**

A sample study according to the variable of "Education" that most of the respondents in the category group (PH.D) which accounted for a percentage (42%), came in the first place, then category group (M.A)

which accounted for present (30.4%), and finally the category group (BA), by present (27.5%), According to the responses of the sample.

- **JOP**

**Table (1/3) Frequency distribution of the variable Job**

| JOP | | | | | |
|---|---|---|---|---|---|
| **Serial** | **Item** | **Frequency** | **Percent** | **Valid Percent** | **Cumulative Percent** |
| **1** | **demonstrator** | 19 | 27.5 | 27.5 | 27.5 |
| **2** | **Teaching Assistant** | 21 | 30.4 | 30.4 | 57.9 |
| **3** | **Teacher** | 24 | 34.8 | 34.8 | 92.7 |
| **4** | **Professor** | 5 | 7.3 | 7.3 | 100.0 |
| **5** | **Total** | **69** | **100.0** | **100.0** | |

**From the above table it is clear:**

A sample study according to the variable of "Job" that most of the respondents in the category group (Teacher) which accounted for a percentage (34.8%), came in the first place, then category group (Teaching Assistant) which accounted for present (30.4%), and the category group (demonstrator), by present (27.5%), and the category group (Professor) , by present (7.3%), According to the responses of the sample.

## 1/7/2 Descriptive statistics

The following part deal with descriptive statistics for the variables of the research by showing data from the tables and determining phrase with the highest level of agree and the lowest level of agree in accordance with the response of the research sample and then showing the general trend of the research items by looking at the at the percentage coefficient of variation. Survey questions was a five levels (likert scale), starting with strongly disagree, disagree taking the value of 2, neither agree nor disagree, then agree, and strongly agree.

**Table (1/4) likert scale**

| Scale | Interval |
|---|---|
| **1 - 1.79** | **(Strong disagree)** |
| **1.80 - 2.59** | **(Disagree)** |
| **2.60 - 3.29** | **(Entirely)** |

| | |
|---|---|
| **3.30 – 4.19** | **(Agree)** |
| **4.20 – 5** | **(Strong agree)** |

## 1/7/2/1 Research variable:

using life cycle costing, as a promising environmental management accounting tool, on enhancing companies sustainability through improving their environmental and profitability performance.

## 1/7/2/2 Reliability and validity of the study:

The researcher used to check the reliability coefficient Alpha cronbach, to measure the stability of the content variables of the study, it was found that coefficient to check the total of the axes of the research "**Using Life Cycle Costing approach For Enhancing Sustainability In The Light Of Value Chain Requirements**" has reached stability coefficient for the total sample size (0.917), which indicates that the high degree of persistence of the study sample, and it effect has been reflected Validity (Which represents the square root) was (0.957).

## 1/7/2/3 Descriptive statistics for the research variable:

- **Life cycle costing**

**Table (1/5) Descriptive Statistical (Arithmetic mean, standard deviation and coefficient of variation) of the "life cycle costing"**

| Items | Mean | Std. | CV |
|---|---|---|---|
| 1- The importance of having awareness and awareness among the employees of the facility of the product life cycle costing system. | 4.10 | .68 | 16.80 |
| 2- There is importance and necessity to know each stage of the product life cycle. | 4.10 | .73 | 17.81 |
| 3- Taking into account the environmental impact of product ideas in the research and development stage helps in reaching products that are expected to be environmentally friendly. | 4.24 | .73 | 17.32 |
| 4- Providing information on environmental costs by analyzing the costs of the product life cycle and for all its stages. | 4.13 | .85 | 20.72 |

| | | | |
|---|---|---|---|
| 5- Provide information on the cost of the product by characterizing, identifying and quantifying all expected sacrifices during the life cycle of the product until its disposal. | 4.10 | .82 | 20.11 |
| 6- Contribute to the achievement of cost management objectives by providing information on the expected benefits of the product throughout its life. | 4.00 | .64 | 16.04 |
| 7- Providing information on the economic feasibility of the product by matching the benefits and sacrifices of the product across its life cycle. | 4.11 | .67 | 16.42 |
| 8- Reconsidering the post-production stage and studying the costs of recycling and disposing of waste in a proper way will help preserve the environment. | 4.00 | .85 | 21.43 |
| 9- Accurate tracking of costs and each production stage, even after production, provides information that contributes to reducing those costs more accurately. | 4.07 | .67 | 16.48 |
| 10- The product life cycle costs system increases the tracking of environmental costs at each stage of the product life cycle. | 4.18 | .67 | 16.00 |
| 11- Studying and analyzing the expected environmental effects of the product in the research, development and design stage and translating them into expected costs to eliminate adverse environmental effects. | 4.10 | .71 | 17.31 |
| 12- Study and analyze the expected environmental impacts of the product at the production stage and translate them into expected costs to be incurred to remove adverse environmental impacts. | 4.14 | .49 | 11.90 |
| 13- Study and analysis of the expected environmental effects of the product at the stage of sale, distribution and customer services are translating them into the expected costs of removing adverse environmental impacts. | 4.21 | .53 | 12.77 |

| | | | |
|---|---|---|---|
| 14- Waste recycling activities and waste disposal activities are among the post-production activities that the company should pay great attention to. | 3.94 | .83 | 21.26 |
| **Total: dimensions** | **4.10** | **.49** | **12.10** |

**From the above table it can be concluded that:**

The trends in variables research sample had shown a general trend to the (agree) on variable of "life cycle costing" with a mean (4.10), coefficient of variation (12.10%), and differences in variance‘s ability (87.9%).

The high degree of agreement was about the following items, (Study and analyze the expected environmental impacts of the product at the production stage and translate them into expected costs to be incurred to remove adverse environmental impacts), (Study and analysis of the expected environmental effects of the product at the stage of sale, distribution and customer services are translating them into the expected costs of removing adverse environmental impacts), with a coefficient of variation, (11.90%), (12.77%), respectively.

Which mean that it's important to use life cycle cost accounting approach for pre-determination of the environmental impact of the product from the design stage and during the production till the disposal of the product, for eliminating the adverse environmental impact.

The less degree of agreement was about, (Reconsidering the post-production stage and studying the costs of recycling and disposing of waste in a proper way will help preserve the environment), with coefficient of variation calculation (21.43%) according to the total variables of the study sample.

## 1/7/3 One Sample T-Test:

The hypothesis tests, " Using Life Cycle Costing approach For Enhancing Sustainability In The Light Of Value Chain Requirements ", the researcher used **One Sample T-Test** to confirm the credibility of this, hypothesis has been reformulated in the form of Null hypothesis as follows:

**Null Hypothesis:**

**H1**: there is no relationship between the application of life cycle costing system and the accurate treatment of environmental costs and improving efficiency throughout the product life cycle.

**Table (1/6) T.Test to measure the significant differences between study sample and study population to measure the relationship between the application of life cycle costing system and the accurate treatment of environmental costs and improving efficiency throughout the product life cycle. Noting that population parameter is (3.3)**

| Items | Significance level | | | |
|---|---|---|---|---|
| | Mean | t-test | p-value | Sig |
| 1- The importance of having awareness and awareness among the employees of the facility of the product life cycle costing system. | 4.10 | 9.66 | .000 | **Sig** |
| 2- There is importance and necessity to know each stage of the product life cycle. | 4.10 | 9.11 | .000 | **Sig** |
| 3- Taking into account the environmental impact of product ideas in the research and development stage helps in reaching products that are expected to be environmentally friendly. | 4.24 | 10.68 | .000 | **Sig** |
| 4- Providing information on environmental costs by analyzing the costs of the product life cycle and for all its stages. | 4.13 | 8.05 | .000 | **Sig** |
| 5- Provide information on the cost of the product by characterizing, identifying and quantifying all expected sacrifices during the life cycle of the product until its disposal. | 4.10 | 8.06 | .000 | **Sig** |
| 6- Contribute to the achievement of cost management objectives by providing information on the expected benefits of the product throughout its life. | 4.00 | 9.06 | .000 | **Sig** |
| 7- Providing information on the economic feasibility of the product by matching the benefits and sacrifices of | 4.11 | 10.02 | .000 | **Sig** |

| | | | | |
|---|---|---|---|---|
| the product across its life cycle. | | | | |
| 8- Reconsidering the post-production stage and studying the costs of recycling and disposing of waste in a proper way will help preserve the environment. | 4.00 | 6.78 | .000 | **Sig** |
| 9- Accurate tracking of costs and each production stage, even after production, provides information that contributes to reducing those costs more accurately. | 4.07 | 9.55 | .000 | **Sig** |
| 10- The product life cycle costs system increases the tracking of environmental costs at each stage of the product life cycle. | 4.18 | 11.01 | .000 | **Sig** |
| 11- Studying and analyzing the expected environmental effects of the product in the research, development and design stage and translating them into expected costs to eliminate adverse environmental effects. | 4.10 | 9.37 | .000 | **Sig** |
| 12- Study and analyze the expected environmental impacts of the product at the production stage and translate them into expected costs to be incurred to remove adverse environmental impacts. | 4.14 | 14.22 | .000 | **Sig** |
| 13- Study and analysis of the expected environmental effects of the product at the stage of sale, distribution and customer services are translating them into the expected costs of removing adverse environmental impacts. | 4.21 | 14.14 | .000 | **Sig** |
| 14- Waste recycling activities and waste disposal activities are among the post-production activities that the company should pay great attention to. | 3.94 | 6.36 | .000 | **Sig** |
| **Total: dimensions** | **4.10** | **13.44** | **.000** | **Sig** |

**From the above table it can be concluded that:**

The agreement of the study sample upon that there are a relationship between the application of life cycle costing system and the accurate treatment of environmental costs and improving efficiency throughout the product life cycle, with a (P.Value less than 5%), indicating the rejection of null hypothesis and the acceptance of alternative hypothesis which states that the (mean of population study is 4.10 greater than 3.3), that supports there are a relationship between the application of life cycle costing system and the accurate treatment of environmental costs and improving efficiency throughout the product life cycle and means the importance of applicant of that approach then the validity of research hypothesis.

## 1/8 Results

- The life cycle costing approach provides the appropriate justification for the production of a new product by planning the costs of the full life cycle of this product and determining its revenues during the life cycle of the product, which must be sufficient to cover all costs in the life cycle.
- The life cycle costing approach expands the scope of the cost system by activities so that the cost measurement includes the elements of the expected costs in the future such as the cost of warranty and also the intangible costs as a result of any impact on the reputation of the company or the product as a result of unexpected failures of the product.
- The use of life cycle costing approach in light of the requirements of the value chain works to address the shortcomings in the production process, which leads to increased competitiveness, improvement of the production process, more efficient management of resources and reduction of costs for each stage.

## 1/9 Recommendations

- The company must be made aware of using more than one of the modern approaches to cost management, such as strategic analysis, balance scorecard measurement, total quality management, product life cycle costs, and an attempt to link them through seminars and scientific courses through universities and scientific institutes in order to achieve strategic cost management.

- The necessity of conducting several applied studies to integrate the, material flow cost accounting, and product life cycle costing through continuous improvement in order to achieve competitive advantages for companies.
- The need to study and analyze the integrative relationship between other modern approaches of cost management and try to benefit from them in supporting the competitive ability of enterprises to achieve environmental and economic sustainability.

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