

Life Cycle Made Simple

Contents

- 01 Life Cycle Cost Analysis – Economic Impact
- 01 Life Cycle Assessment – Environmental Impact
- 02 How to Calculate Life Cycle Cost
- 03 Worksheet for Calculating Life Cycle Cost
- 04 The Life Cycle Cost Analysis Process
- 04 Factors Impacting LCCA
- 04 Using the Environmental Product Declarations (EPDs)
- 04 References

Product life cycle considers the impacts of a product from a holistic perspective. This perspective can include both the economic and environmental impacts on a project, product or system. When costs are considered, people refer to Life Cycle Cost Analysis (LCCA) to understand the economic impact. To understand the environmental impacts, Life Cycle Assessment (LCA) is used. This paper will explain the workings of both of these evaluation tools.

Life Cycle Cost Analysis–Economic Impact

Life Cycle Cost Analysis is a method used to assess the total cost of ownership for a project. LCCA takes into account all of the economic impacts of products for consideration, and creates an apples to apples comparison of the design alternatives.¹ LCCA is most effective when used early in the design phase of a project, as it enables decision-makers to select products based on the long-term economic analysis of each, and not simply the first cost. By comparing product LCCA results trade-off can be made between high initial cost items and long-term operating costs/savings. LCCA has gained popularity in recent years as an economic management tool. The LCCA method provides a standardized assessment approach that helps remove divisional conflicts within organizations, by accounting for all associated costs and benefits. The end result is a robust economic comparison of product alternatives over time, and an improved understanding of how periodic costs impact the total cost of ownership.

It should be noted that LCCA is flexible by design and allows for the incorporation of any unique periodic or reoccurring costs that may

be incurred over the economic evaluation period.

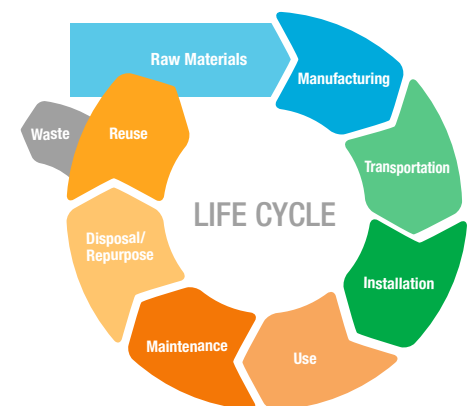
Life Cycle Assessment–Environmental Impact

Life Cycle Assessment (LCA) determines the environmental impact of a product over its lifespan, and is determined using the ISO 14040 standard. LCA is similar to LCCA as it accounts for environmental impacts a product has over its normal life cycle. The major difference between the two assessment tools is that LCA is focused solely on a product's environmental impacts, while LCCA is concerned only with the costs of ownership.

Typically a product's life cycle assessment includes the calculation of environmental impacts at the stages shown in Figure 1.

Many organizations today are basing design decisions on both the environmental and economic implications of a project. Green building initiatives, such as the LEED® rating system, have drawn attention to the importance of LCA and have helped reduce the impact products have on the environment and people working with them.

Figure 1: Product Life Cycle Stages



How to Calculate Life Cycle Cost

The LCC of most flooring products can be calculated using the following equation²:

$$\text{LCC} = \text{Initial Capital Costs} + \text{Future Costs} +/- \text{Disposal/Salvage Costs}$$



Step 1. Determine the Initial Capital Cost.

Table 1: Initial Capital Costs of Flooring Products

Product	Total Installed Cost per ft ²
Luxury Vinyl Tile	\$3.80 – \$4.75
Linoleum	\$3.00 – \$4.40
Bio-based Tile	\$2.10 – \$3.05
Vinyl Sheet	\$2.50 – \$3.25
Vinyl Composition Tile	\$1.50 – \$2.85
Commercial Laminate	\$5.35 – \$7.60
Commercial Hardwood	\$4.00 – \$8.00

(Multiply the total number of ft² by the cost per square foot using the suggested values shown below.)

Step 2. Determine the Replacement Costs.

(Multiply by the number of replacement floors over the life of project by the Initial Capital Cost.)

Step 3. Determine the Average Annual Maintenance Costs per ft².

The “average” costs can be calculated using the following assumptions: Using the values listed above we can prepare a summary of the total

Table 2: Average Annual Maintenance Effort and Frequency of Flooring Products³

Maintenance Task	Work Rate in Minutes per 1,000 ft ² / Events per Year		
	Low	Medium	High
Dust Mop	4/365	5/365	8/365
Wet Mop	8/156	12/365	16/365
Buffing	13/104	20/104	27/104
Scrub/Recoat	17/2	25/3	33/6
Strip/Refinish	28/1	42/1	56/2

annual effort for a 1,000 ft² area by multiplying the minutes per maintenance item for 1,000 ft² by the number of times each occurs per year. The result is then converted from minutes to hours by dividing by 60 (minutes/hour).

Table 3: Calculated Annual Maintenance Effort for 10,000³

Maintenance Task	Maintenance Option (Hours per Year)		
	Low	Medium	High
Dust Mop	243.3	304.2	486.7
Wet Mop	208.0	730.0	973.3
Buffing	225.3	346.7	468.0
Scrub/Recoat	5.7	12.5	33.0
Strip/Refinish	4.7	7.0	18.7
Total (Hours/Year)	687.0	1,400.3	1,979.7
Total Annual Maintenance Cost @ \$18.40/hour	\$12,640.80	\$25,766.13	\$36,425.87

Once we calculate the level of effort required for each maintenance option we are able to apply the labor rate to calculate the annual maintenance costs. In this example we define an hourly labor rate that is inclusive of cleaning supplies. In contrast, the cost of cleaning materials could be determined using historical accounting records or other industry standards.

Table 4: Average Annual Maintenance Costs of Flooring Products³

Product	Cost per ft ² based on Maintenance Option		
	Low	Medium	High
Hard/Resilient Surfaces	\$1.26	\$2.57	\$3.64

The Average Annual Maintenance Costs of the flooring product can be calculated by dividing the Total Annual Maintenance Costs per year by the total ft² of product.

Step 4. Determine the Disposal/Salvage Costs.

Assume \$0.75 per ft² or insert local costs. (Multiply the cost per ft², or local costs, by the total number of ft² of product.)

Step 5. Determine the Total LCC of the Project.

Use the worksheet on the following page to calculate the total life cycle costs for your project. Environmental Product Declarations (EPDs) are communication tools that provide the results of a product’s LCA.

Worksheet for Calculating Life Cycle Cost

This worksheet can be used to calculate your life cycle cost. The life cycle cost of flooring will vary based on space function, traffic levels, flooring types and desired appearance.

Using the information from Steps 1-4 complete the following worksheet to calculate the total life cycle costs for your project.

	Steps	Example Project	Example Costs	Your Project**	Your Project Costs
Initial	Step 1: Determine the Initial Capital Costs				
	Product	LVT			
	ft ² of product	10,000			
	Installed Product Cost per ft ²	\$6.00			
	Initial Capital Cost	\$6.00 x 10,000	\$60,000.00		
Future	Step 2: Determine the Replacement Costs				
	Life Expectancy (Years)	15			
	Life of Project (Years)	10			
	Replacement Cost	0 x \$60,000	\$0		
	Step 3: Determine the Average Annual Maintenance Costs per ft²				
	Maintenance Option	Low			
Total Maintenance Effort (Hours/Year)	687				
Labor Rate	\$18.40				
Total Annual Maintenance Costs (Table 3)	687 x \$18.40	\$12,640.80			
	Total Maintenance Costs (Life of the Project)	\$12,640.80 x 10	\$126,408.00		
Disposal/Salvage	Step 4: Determine the Disposal/Salvage Costs				
	Rate per ft ² OR local cost	\$0.75			
	Total Disposal/Salvage Cost	\$0.75 x 10,000	\$7,500.00		
Total LLC*			\$193,908.00		

*Calculations do not reflect cost escalation or inflation rates.

**Results will vary based on market segment, specific conditions, and maintenance practices.

The Life Cycle Cost Analysis Process¹

- 1. Establish Clear Objectives for Analysis** – Since LCCA is an economic analysis tool useful for the comparison of life cycle costs for product alternatives, a typical objective is to determine which alternative has the lowest cost of ownership.
- 2. Determine the Criteria for Evaluating Alternatives** – It is important for a company to discuss and document the primary metrics and variables that will be used for their decision making. Normally this would include payback thresholds, internal return rates (i.e. discount rate), and expected performance criteria (i.e. life expectancy, traffic levels, etc.).
- 3. Identify Base Case and Develop Alternatives** – Typically a maximum of five alternatives is sufficient to provide enough information to make a decision. In all cases the alternatives being compared need to fulfill the same basic functional requirements.
- 4. Gather Cost Information** – For each alternative, gather and document all relevant costs associated with ownership for the assessment period. Costs that are incurred equally for each alternative (i.e. product cost) can be ignored to simplify the calculation process.
- 5. Calculate the Life Cycle Cost for each Alternative** – Analyze the alternatives by calculating the net present value of each – then compare the results using the previously defined evaluation criteria. For products with similar economic performance a second set of criteria, such as environmental impact, may be used to make the final decision.

Of all the LCC cost categories, most decision makers will place heavy focus on the initial capital costs and choose to ignore the remaining categories, as these expenses occur some time in the future. Since LCCA is focused on all expected costs the result provides a snap shot of the true cost of ownership.

Maintenance costs, in particular labor costs, over the service life of a floor are typically the largest component of LCCA, but are often overlooked by decision makers. The impact of these costs on the overall life cycle cost can vary significantly, as they depend on a wide number of variables such as:

- **Space Function** – Often determines the level of traffic as well as the odds of damage due to leaks, spills, etc.
- **Traffic/Soil Levels** – High traffic areas require a more durable walking surface and normally require an increase in maintenance effort. The frequency and cost of traffic specific maintenance should be estimated and included in the LCCA.

- **Ease of Maintenance** – Different flooring types require different methods of maintenance.
- **Space Churn** – High levels of client turn over, or churn, can have a significant impact on the overall life cycle cost as it often includes re-flooring for new tenants. For commercial rental space the churn timeline should be estimated and the anticipated replacement costs should be included in the LCCA.
- **Appearance** – Maintenance levels will vary based on end user desired appearance.

Factors Impacting LCCA

The life cycle cost of flooring products will differ significantly depending on the application. For example, different facility types will have different occupancy and traffic rates, as well as maintenance practices and procedures. While a school may only mop floors three times per week, a health facility would ensure this is done daily. Additionally, the level of soiling due to traffic rates will reduce the work rate and the useful service life of the flooring.^{4,5}

In order to accurately reflect the impact of maintenance on the cost of ownership an LCCA must factor in the tasks required to maintain a particular flooring type, the work rate (time to complete each task), the frequency each task is completed, the labor rate (cost per unit of time), and chemical/material costs. Similarly, replacement costs should be factored in for products with a lower life expectancy than that of the life cycle analysis period, and/or installations that have a high level of space churn.

Using the Environmental Product Declarations (EPDs)

Not only are overall project costs dependent on selected maintenance methods but the same is true for environmental impacts. The range of environmental impacts can be calculated by replacing dollars with the environmental impact variable of interest to you.

Final Thoughts

As illustrated by the comparative example, a number of factors influence the overall Life Cycle Cost of any product. Careful consideration must be given to all reasonable costs that will be incurred over the anticipated life of the product alternatives. Three space types of the same size may have identical product installation costs, but may have significantly different life cycle costs due to variations in occupancy/traffic levels, maintenance requirements, labor rates and space churn. LCCA provides a standardized method of assessing the total cost of product ownership, which can be used in conjunction with LCAs/EPDs to make an informed, and balanced decision.

References

1. Stanford University Land and Buildings, (2005). Guidelines for Life Cycle Cost Analysis.
2. Alan S. Bigger (2004). Flooring Considerations: Facts Under Foot.
3. Jeff Bishop, Institute of Inspection, Cleaning, and Restoration Certification (2002). A Life Cycle Cost Analysis for Floor Coverings in School Facilities.
4. The Janitorial Store (2005). Production Cleaning Rates.
5. Sciedu Press, Journal of Hospital Administration (2015 Vol. 4, No. 4). A life-cycle cost analysis for flooring materials for healthcare facilities.

William Marshall, PE is a partner at Equilibrium Engineering, Inc.