Life Cycle Costing

Taking out the Mystery

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Life Cycle Costing

Taking out the Mystery

- What is Life Cycle Costing (LCC), Formal Definition
  - The National Institute of Standards and Technology (NIST) Handbook 135, 2013 edition, defines **Life Cycle Cost (LCC)** as "the total discounted dollar cost of owning, operating, maintaining, and disposing of a building or a building system" over a period of time.
  - Or, Life Cycle Cost is the total discounted dollar cost of owning, operating, maintaining, and disposing of a building or a building system over a period of time. Keeping this definition in mind, one can breakdown the LCC equation into the following three variables: the pertinent **costs** of ownership, the period of **time** over which these costs are incurred, and the **discount rate** that is applied to future costs to equate them with present day costs.
- Life Cycle Costing Analysis (LCCA)
  - Life Cycle Cost Analysis(LCCA) is an economic evaluation technique that determines the total cost of owning and operating a facility over period of time.

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- The real meaning of Life Cycle Cost Analysis as it pertains to a building or infrastructure.
  - Life Cycle Cost Analysis can be performed on large and small buildings or on isolated building systems. Many building owners apply the principles of life cycle cost analysis in decisions they make regarding construction or improvements to a facility. From the school who opts for metal siding in lieu of wood to the highway project that chooses concrete paving over asphalt, both owners are taking into consideration the future maintenance and replacement costs in their selections.

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- The nuts and bolts of performing a Life Cycle Cost Analysis (LCCA)

- Elements of the LCCA
  - Cost of ownership
  - Life Expectancy
  - Discount Rate
  - Net Present Value (NPV)

- Cost of Ownership
  - The Cost of Ownership is comprised of the **initial (capital) costs** incurred prior to occupancy or beneficial use and **future expenses**, all costs incurred after initial occupancy or use.

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- What are future costs?
  - Operating Costs (annually)
  - Maintenance and Repair Costs, scheduled and unscheduled
  - Replacement Costs
  - Salvage Value
- Operating Costs
  - Heating Fuel
  - Electricity
  - Water and Sewer
  - Garbage Disposal
  - Custodial
  - Grounds
  - Lease
  - Insurance

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- Maintenance and Repair Costs, scheduled and unscheduled
  - Site Improvements
  - Site Utilities
  - Structural Systems
  - Exterior Closure
  - Interior Architectural Systems
  - Conveying
  - Fire Suppression
  - Plumbing
  - HVAC Systems
  - Electrical Systems incl low voltage

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- Replacement Costs
  - These are costs that are associated with the normal wear and tear of system components;
    - Roofs
    - Electrical panelboards
    - HVAC Fans
    - Pumps
    - Light fixtures
    - Etc.
  - Several resources are available to help in determining the replacement period for system components;
    - Owner’s history with similar systems
    - Whitestone Facility Maintenance And Repair Cost Reference
    - United States Army Corps of Engineers
    - Vendor Data

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- Salvage Value
  - **T**he net worth of a building or building system at the end of the LCCA study period. Most often used with vertical construction v. infrastructure.

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- Life Expectancy
  - The is the period of time over which ownership and operations expenses are to be evaluated. Typically for vertical construction the life expectancy can range from twenty to forty years, depending on owner's preferences and the intended overall life of the facility. For infrastructure projects the life expectancy can range from fifty to one hundred years.

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- Discount Rate
  - The discount rate, as defined by Life Cycle Costing for Design Professionals, 2nd Edition, is “the rate of interest reflecting the investor’s time value of money.” Basically, it is the interest rate that would make an investor indifferent as to whether he received a payment now or a greater payment at some time in the future.
  - To establish a standard discount rate to be used in LCCA, many agencies adopted the US Department of Energy’s real discount rate. This rate is updated and published annually in the Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis – Annual Supplement to NIST Handbook 135.
  - For purposes of LCCA in the Puget Sound region, 3.5% has been extensively used.

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- Net Present Value
  - Net Present Value (NPV) is the difference between the present value of cash inflows and the present value of cash outflows. NPV is used in capital budgeting to analyze the profitability of a projected investment or project.

- Putting the Pieces Together
  - Sample Excel Spreadsheet for Performing a Life Cycle Cost Analysis

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LIFE CYCLE COSTS				JOHN LANGER CONSULTING	
PROJECT:				**Idea No.**	**Alt No.**
TITLE:					
Life Cycle Period		Years		**ORIGINAL**	**ALTERNATIVE**
Interest	3.5	30			
A. INITIAL COST					
INITIAL COST SAVINGS:					
B. ANNUAL COSTS					
1. General Operations & Maintenance					
2. Energy					
3. Supplies & Misc.					
Total Annual Costs:					
Present Value Factor (P/A):					
PRESENT VALUE OF ANNUAL COSTS:					
C. SINGLE EXPENDITURES	**Year**	**Amount**	**PV Factor**	**Present Value**	**Present Value**
1.			1.0000		
2.			1.0000		
3.			1.0000		
4.			1.0000		
5.			1.0000		
6.			1.0000		
PRESENT VALUE OF SINGLE EXPENDITURES:					
D. TOTAL ANNUAL COSTS & SINGLE EXPENDITURES (B+C)					
E. SALVAGE VALUE					
F. TOTAL PRESENT VALUE COST (A+D+E)					
TOTAL LIFE CYCLE COSTS:					

Courtesy of John Langer Consulting

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- Sample LCCA for a Transit Project

LIFE CYCLE COST WORKSHEET							
Transit Example						Alternative No:	0
Life Cycle Period:		**40**	**years**	**Net Discount Rate:**	**4.10%**	**Baseline Concept**	**Alternative Concept**
A.	**Initial Cost**					**$ 62,000**	**$ 0**
B.	**Annual Costs**						
1	Maintenance: Nightly cleaning - 0.25hr x $40/hr x 365days					$3,650	
2	Operating						
3	Energy						
4							
5							
6							
7							
					Total Annual Costs	$ 3,650	$ 0
					Present Worth Factor	19.502	19.502
					Present Worth of Annual Costs	**$ 71,181**	**$ 0**
C.	**Replacement Costs**		**Year**	**Amount**	**PW Factor P/F**	**Present Worth**	**Present Worth**
ORIG	ALT	**< Put "x" in appropriate box (original or alternate design)**					
x		1. Replace Concrete Slab	20	$ 62,000	0.4477	$ 27,757	$ -
x		2. Major repairs/patching	10	$ 3,000	0.6691	$ 2,007	$ -
x		3. Major repairs/patching	30	$ 3,000	0.2996	$ 899	$ -
		4.			1.0000	$ -	$ -
		5.			1.0000	$ -	$ -
		6.			1.0000	$ -	$ -
		7.			1.0000	$ -	$ -
		6.			1.0000	$ -	$ -
		7.			1.0000	$ -	$ -
		7.			1.0000	$ -	$ -
					Present Worth of Replacement Costs	**$ 30,663**	**$ 0**
D.	**Total Annual Costs and Replacement Costs (B + C)**					**$ 101,844**	**$ 0**
E.	***Total Annual Costs and Replacement Costs (B + C) - ROUNDED***					**$ 100,000**	**$0**
	Annual Costs and Replacement Savings - ROUNDED						**$ 100,000**
F.	**Total Present Worth Cost (A + E)**					**$ 163,844**	**$ 0**
	Total Life Cycle Savings						**$ 163,844**
G.	***TOTAL PRESENT WORTH COST (A + E) - ROUNDED***					**$ 162,000**	**$ 0**
H.	***TOTAL LIFE CYCLE SAVINGS - ROUNDED***						**$ 162,000**

Courtesy of Hamilton Value-Risk.

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- Sample LCCA for an Elementary School

ABC Project
XYZ School District
New Elementary School

FUNCTIOI	IDEA #
TITLE: Use VRF and DOAS with Heat Recovery	

Assumptions

Interest/Discount Rate(%):	4%	Economic Life (yrs):	30

LIFE CYCLE COST ANALYSIS

Salvage & Replacement Costs			Baseline		Proposed	
Ite	Description	Yr	Est Cost	Pres Worth	Est Cost	Pres Worth
1	Heat recovery unit	20			103,472	52,001
2	Boiler non-condensing	20	16,452	8,268		
3	Boiler circ pump	15	4,165	2,486		
4	Water to air heat pumps	15	243,806	145,526		
5	VRF systems	15			226,345	135,103
Total Salvage & Replacement Costs			**264,423**	**156,280**	**329,817**	**187,105**

Annual Costs (pres worth calculated over 30 yrs)		Baseline		Proposed	
Ite	Description	Est Cost	Pres Worth	Est Cost	Pres Worth
1	Energy costs ($.06 per kwhr)	660	12,139	588	10,815
2	Maintenance (assume $54/hr)	10,800	198,634	10,098	185,723
3					
4					
5					
Total Annual Costs		**11,460**	**210,773**	**10,686**	**196,537**

SUMMARY	Baseline Present Worth	Proposed Present Worth
Total Present Worth (salvage+annual pres worth)	367,000	384,000
RESULTS (Proposed less baseline)		

Courtesy of the SAZAN Group

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Roadway Project
Your Town

TITLE: Change pavement from PCC to ACP

Assumptions			
Interest/Discount R	3.50%	**Economic Life (**	50

LIFE CYCLE COST ANALYSIS

Salvage & Replacement Costs			**Baseline Assumption**		**Proposed Alternative**	
Ite	**Description**	**Yr**	**Est Cost**	**Pres Vort**	**Est Cost**	**Pres Vorth**
1	Grind and Overlay ACP	20			2,500,000	1,256,415
2	Grind and Overlay ACP	40			2,500,000	631,431
3	Replace 5% of PCC panels	25	4,500,000	1,904,161		
4						
5						
6						
7						
8						
9						
10						
11						
12						
Total Salvage & Replacement Cost			**4,500,000**	**1,904,161**	**5,000,000**	**1,887,846**

Annual Costs (pres worth calculate		**Baseline Assumption**		**Proposed Alternative**	
Ite	**Description**	**Est Cost**	**Pres Vort**	**Est Cost**	**Pres Vorth**
1	Annual pavement repair ACP (assume 1% per year to be patched)			75,000	1,759,171
2					
3					
4					
5					
Total Annual Costs				**75,000**	**1,759,171**

SUMMARY	**Baseline Present Vorth**	**roposed Present Vor**
Total Present Vorth (salvage+annual pres worth)	1,904,000	3,647,000
RESULTS (Proposed less baseline)		

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CENTRAL WATERFRONT CSO CONTROL PROJECT

Pipeline Economic Comparison Matrix

Idea No.: P-14

Use a Cost/Risk evaluation of the pipe/joint alternatives; including installation method applicability

			Capital Cost		O&M					Seismic Event @ Year 25 - Repairs				
Pipe Material/ Joint Type	Sample Pipe Dia. (In)	Sample Pipeline Length (LF)	Capital Cost $/LF	Total Capital Cost ($)	Expected Life (Yrs)	O&M Frequency (Pigging) (Years)	O&M -Unit Cost/LF ($)	Total 50 yr. O&M Cost (PW $)	Total 50 yr. LCC (Capital + O&M) (PW $)	@ Year 25 - Percent of Pipe Replaced (%)	Seismic Event Repair - Unit Cost/LF ($)	Seismic Event @ Year 25 - Total Repair Cost (PW $)	SPU Disruption Impacts (PW $)	Total 50 yr life (PW$)
Vitrified Clay Pipe, Extra Strength	24	1000	$ 200	$ 200,000	50	5	$2	$8,000	$208,000	70%	$1,192	$353,144	$803,890	**$1,365,034**
Ductile Iron Pipe/Push-on Joints	24	1000	$ 230	$ 230,000	50	5	$2	$8,000	$238,000	30%	$1,222	$155,155	$406,176	**$799,331**
PVC Sewer Pipe PS46 F769 with push-on joints	24	1000	$ 132	$ 132,250	50	5	$2	$8,000	$140,250	30%	$1,125	$142,748	$406,176	**$689,174**
Fiberglass Pipe, Hobas, ASTM D3262 with Coupled Joints	24	1000	$ 214	$ 213,630	50	5	$2	$8,000	$221,630	20%	$1,206	$102,052	$249,629	**$573,311**
Steel Pipe, Polyurethane Coated (AWWA C222)	24	1000	$ 260	$ 260,110	50	5	$2	$8,000	$268,110	10%	$1,252	$52,992	$249,629	**$570,731**
Ductile Iron Pipe/Restrained Joints	24	1000	$ 250	$ 250,000	50	5	$2	$8,000	$258,000	10%	$1,242	$52,565	$249,629	**$560,194**
PVC Sewer Pipe PS46 F769 with fusion welded joints	24	1000	$ 142	$ 142,060	50	5	$2	$8,000	$150,060	10%	$1,134	$47,998	$249,629	**$447,687**
HDPE Pipe D4707, DR 11	24	1000	$ 86	$ 86,190	50	5	$2	$8,000	$94,190	10%	$1,079	$45,634	$249,629	**$389,453**
PW Factor .4231														

Notes on SPU Disruptions:

1) Trench was estimated to be 6'W x 16' D
2) Cost for excavation, pipe removal and disposal was estimated to be $247.90/LF
3) Dewatering was estimated to be $280.00/LF
4) Shoring was estimated at $1.80/SF x 16'D x 2 sides ~ 32SF or $57.60/SF
5) Backfill was estimated at $135.79/CY x 3CY per LF or $407.37/LF
6) Total SPU disruption was estimated to be $992.87/LF

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- Questions / Discussion