Life Cycle Analysis

Last Updated: October 24, 2019; First Released: September 12, 2013

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Version: 2.2.0

A. Introduction

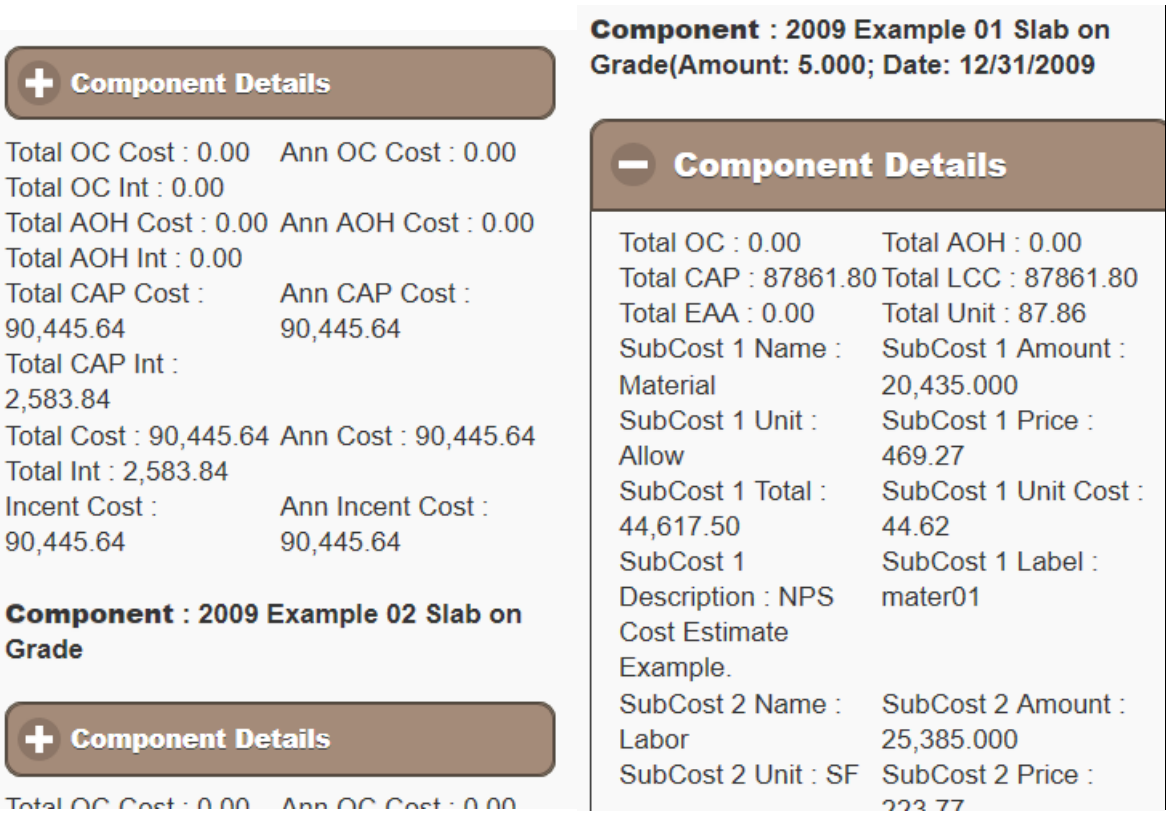
This reference explains how to start to collect, measure, and analyze, life cycle benefit and cost data (**1***). DevTreks believes that every public investment, from the pothole in the street to the bridge spanning the river, has a story to tell and lessons to teach. Those lessons can only be learned when data about the investment is collected, measured, aggregated, analyzed, and saved in online knowledge banks. A full, uniform, and accurate accounting of the costs, benefits, and outcomes for every dollar spent on bridges, students, medical treatments (**2***), highways, hurricanes, earthquakes, floods, wetlands, sanitation systems, safety services, and yes, potholes, should be one or two links away for everyone. If the public is paying for it, the public has the right to know how well their money is being spent. This reference introduces another DevTreks way to build knowledge banks.

B. Data URLs

The Construction Analysis 1 tutorial demonstrates how public infrastructure data can be structured to support the analyses shown in this reference. The actual data used in this analysis was structured for the purpose of testing these analyzers. Much of the testing data was required to match the results of the USNPS (2011) reference cost estimate. That estimate does not utilize normal life cycle calculation techniques, such as discounting or escalating.

The Analyzers and sample data demonstrated in this reference can be found at the following URLs. The data is fictitious and no weight should be assigned to the absolute numbers –pay attention to the aggregation techniques only. Refer to Footnote 1. These date sets also contain NPV calculators and analyzers. We recommend confirming, and understanding, the differences, as demonstrated in the following image, between these results and those documented in the Benefit Cost Analysis 1 reference. The most prominent difference occurs when the data being analyzed does not use LCA calculators for every input and output –LCA Analysis only analyzes the results generated by LCA calculations.

NPV vs LCC Totals Analysis (examine the NPV discounted interest)



Component Details

Total OC Cost : 0.00 Ann OC Cost : 0.00
Total OC Int : 0.00
Total AOH Cost : 0.00 Ann AOH Cost : 0.00
Total AOH Int : 0.00
Total CAP Cost : 90,445.64 Ann CAP Cost : 90,445.64
Total CAP Int : 2,583.84
Total Cost : 90,445.64 Ann Cost : 90,445.64
Total Int : 2,583.84
Incent Cost : 90,445.64 Ann Incent Cost : 90,445.64

Component : 2009 Example 02 Slab on Grade

Component Details

Total OC Cost : 0.00 Ann OC Cost : 0.00

Component : 2009 Example 01 Slab on Grade(Amount: 5.000; Date: 12/31/2009

Component Details

Total OC : 0.00 Total AOH : 0.00
Total CAP : 87861.80 Total LCC : 87861.80
Total EAA : 0.00 Total Unit : 87.86
SubCost 1 Name : Material SubCost 1 Amount : 20,435.000
SubCost 1 Unit : Allow SubCost 1 Price : 469.27
SubCost 1 Total : 44,617.50 SubCost 1 Unit Cost : 44.62
SubCost 1 Description : NPS Cost Estimate Example. SubCost 1 Label : mater01
SubCost 2 Name : Labor SubCost 2 Amount : 25,385.000
SubCost 2 Unit : SF SubCost 2 Price : 223.77

Analyzers URI:

https://www.devtreks.org/buildtreks/preview/commercial/linkedviewgroup/Life Cycle Cost and Benefit Analyzers/50/none/

https://localhost:5001/buildtreks/preview/commercial/linkedviewgroup/Life Cycle Cost and Benefit Analyzers/47/none

Components URI:

https://www.devtreks.org/buildtreks/preview/commercial/componentgroup/LCC Analysis Example 01/657/none/

https://localhost:5001/buildtreks/preview/commercial/componentgroup/Life Cycle Comp Analysis Examples/657/none

Operations URI:

https://www.devtreks.org/buildtreks/preview/commercial/operationgroup/NPS Trailhead Group/757/none/

Outcomes URI:

https://www.devtreks.org/buildtreks/preview/commercial/outcomegroup/National Park Recreation Outcomes/33/none/

https://localhost:5001/buildtreks/preview/commercial/outcomegroup/Life Cycle Outcome Examples/33/none

Capital Budgets URI:

https://www.devtreks.org/buildtreks/preview/commercial/investmentgroup/Public Infrastructure Analysis Example/275505677/none/

https://localhost:5001/buildtreks/preview/commercial/investmentgroup/Public Infrastructure Analysis Example/275505677/none

Operating Budgets URI:

https://www.devtreks.org/buildtreks/preview/commercial/budget/Public Infrastructure Op Budget/273083901/none/

Multimedia URI:

https://www.devtreks.org/buildtreks/preview/commercial/resourcegroup/Life Cycle Assessment Stories/140/none/

Story URI:

https://www.devtreks.org/buildtreks/preview/commercial/linkedviewgroup/Life Cycle Cost and Benefit Stories/51/none/

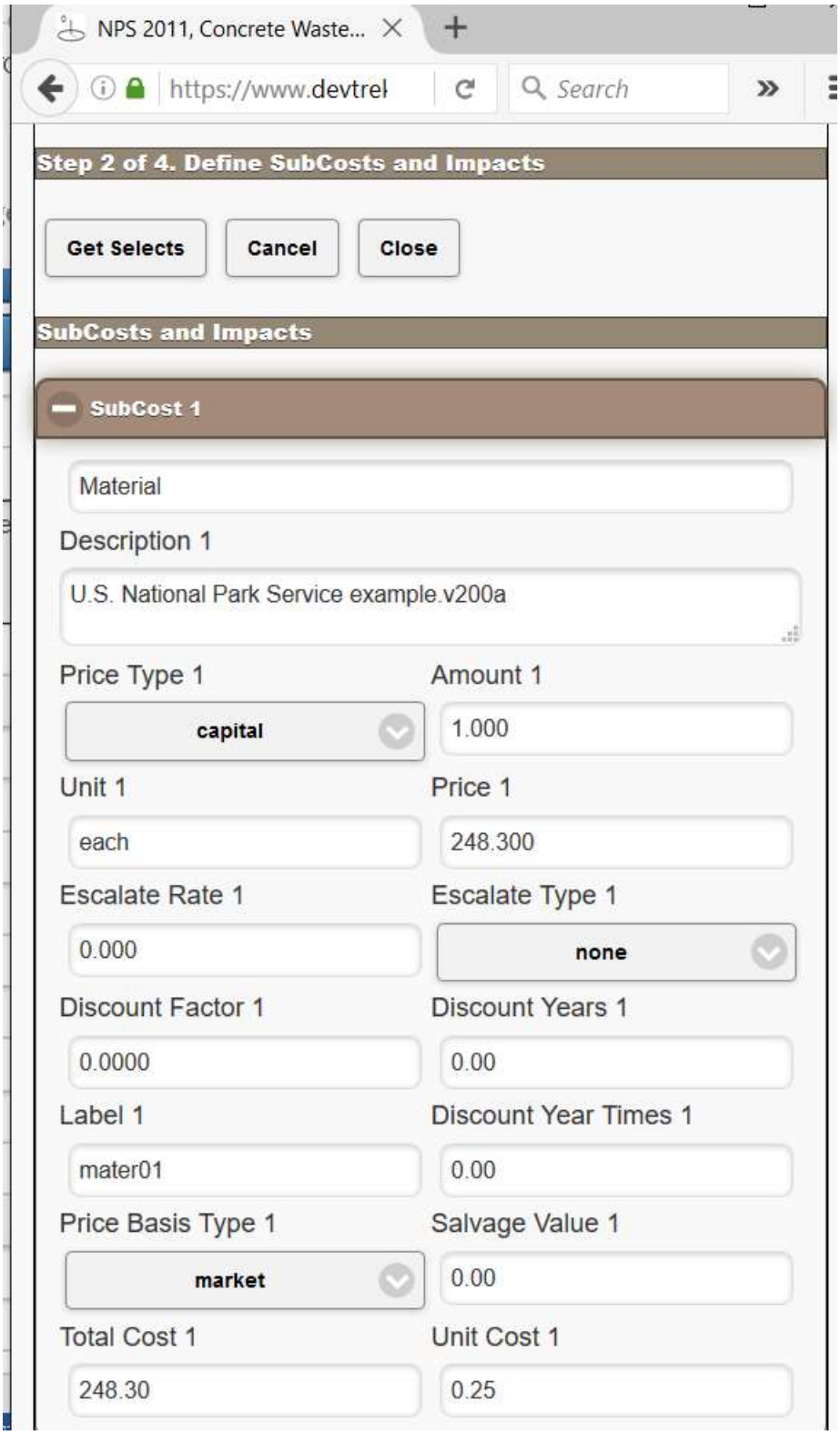
C. Work Breakdown Structure (WBS)

Much of the Input and Component data used in this reference is classified using the UNIFORMAT II building construction WBS. The remaining date used fictitious WBSs. All of the data used in these analyses, including the SubCosts and SubBenefits, were aggregated using these WBS Labels.

D. Life Cycle (LCA) Calculations

The Life Cycle Calculation introductory reference documents the Input and Output calculations that will be aggregated and analyzed in this reference. A typical SubCost calculation is displayed in the image that follows. These SubCosts and SubBenefits will be referred to as Life Cycle

(LCA) elements in this reference. Their parent base elements (Input, Output, Operation, Component, Outcome, Operating Budget, Capital Budget, elements) will be referred to as base elements.


NPS 2011, Concrete Waste...
https://www.devtrel
Search
Step 2 of 4. Define SubCosts and Impacts
Get Selects
Cancel
Close
SubCosts and Impacts
SubCost 1
Material
Description 1
U.S. National Park Service example.v200a
Price Type 1
capital
Amount 1
1.000
Unit 1
each
Price 1
248.300
Escalate Rate 1
0.000
Escalate Type 1
none
Discount Factor 1
0.0000
Discount Years 1
0.00
Label 1
mater01
Discount Year Times 1
0.00
Price Basis Type 1
market
Salvage Value 1
0.00
Total Cost 1
248.30
Unit Cost 1
0.25

E. Social Benefits

For the most part, the Outputs and Outcomes used for measuring the value of public investments will be unsatisfactory. As a public benefit charity, that concerns DevTreks. The measurement of social benefits remains a firm goal of this organization. However wanting, DevTreks recommends that Outputs and Outcomes be included in all budgets. Clear recognition of the shortfall means clear understanding of the need for the development of new tools that can measure social benefits, as demonstrated in the Social Performance Analysis tutorial.

F. LCA Analyses

Separate LCA analyzers are available for the base elements found in Inputs, Outputs, Operations, Components, Outcomes, Operating Budgets, and Capital Budgets. The Calculator and Analyzer 1 reference documents how all DevTreks' Analyzers work. The Analysis Type property of LCA Analyzers is used to specify the type of analysis to run. This version of the analyzers ignores any Input and Output that has not been calculated using a base LCA Input and Output calculator.

Each analysis will display up to 10 aggregated LCA elements for each base element (**4***). The Price Analysis 1 reference documents how these Analyzers are used with Inputs and Outputs.

Analysis Result Properties (5*): The results of running analyses are displayed using the following basic properties (which are explained more thoroughly in the Life Cycle Calculation 1 reference):

Cost Properties

Total OC: Total Operating Costs

Total AOH: Total Allocated Overhead Costs

Total CAP: Total Capital Costs

Total LCC: Total Life Cycle Costs

Total EAA: Total Equivalent Annual Annuity Costs

Total Unit: Total Unit Costs

Benefit Properties

Total R: Total Benefits

Total LCB: Total Life Cycle Benefits

Total REAA: Total Equivalent Annual Annuity Benefits

Total RUnit: Total Unit Benefits

Appendix A, Life Cycle Analysis Examples, demonstrates how these properties are used with the 4 different types of analyses available.

G. Performance Analysis

The data generated by the LCA Analyzers can be used in Performance Measures to judge the worthiness of investments. These Measures, which include Net Returns, Net Savings, Return on Investment, Percent over or under Budget, Estimated Date of Completion, Output per Unit Input, and Input per Unit Output, are documented in the Performance Analysis 1 reference. Note that the Benefit Costs Analysis 1 reference demonstrates that NPV Analyzers offer a less detailed, and quicker, way of measuring performance.

Version 2.0.8's Social Performance Analysis tutorial documents that life cycle costs and benefits can now be run using TEXT datasets and a new algorithm. Additional new algorithms tackle measuring the social impacts that firms have on a community's public goods. The Social Performance Analysis tutorial explains how to value the services generated by public goods using techniques such as Monitoring and Evaluation, Performance Monitoring, Impact Evaluation, and Cost Effectiveness Analysis.

H. LCA Analysis, Net Present Value (NPV) Analysis, Monitoring and Evaluation (M&E), and Resource Stock Analysis

Most LCA Analyzers require running a base Net Present Value calculator before an analysis can be run (Input and Output LCA analysis are exceptions because they don't need NPV Analysis). NPV calculation contains the basic data needed to understand benefits and costs. All of the Input and Output data used in NPV calculations can be generated automatically from LCA calculators. Read the Life Cycle Analysis 1 reference to learn how to avoid "double discounting".

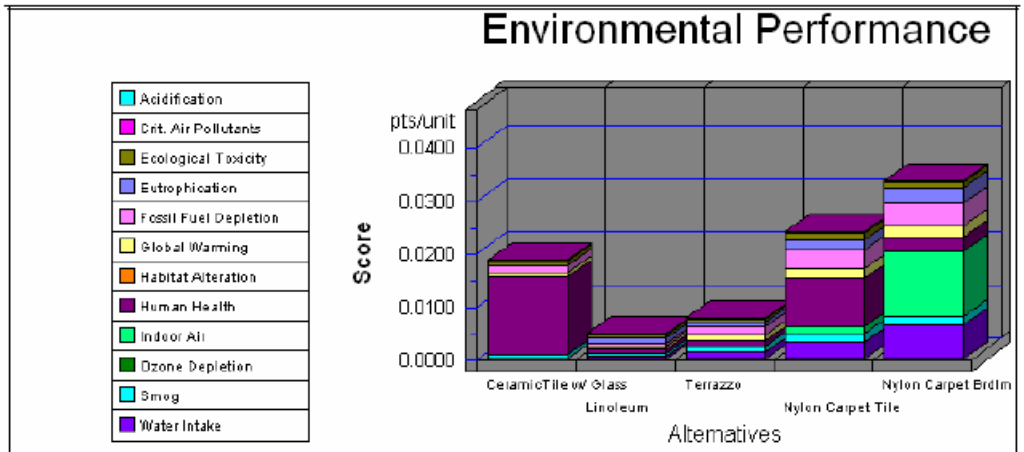
M&E and Resource Stock Analysis are often used together with NPV and LCA Analysis to tie monetary benefits and costs to nonmonetary indicators of performance and outcomes. Cost effectiveness analyses are conducted using both sets of data.

I. LCA Input and Output Price Analysis

The LCA Analysis of Input and Output Prices can be found in the Price Analysis 1 reference.

I. LCA Multimedia (Resources)

Full multimedia includes pictures and videos that support the stories that must accompany each analysis. The following graphic (taken from the Lippiatt (2007) reference in the Resource Stock Analysis tutorial) summarizes the results from a natural resource life cycle analysis of building construction.



Note: Lower values are better

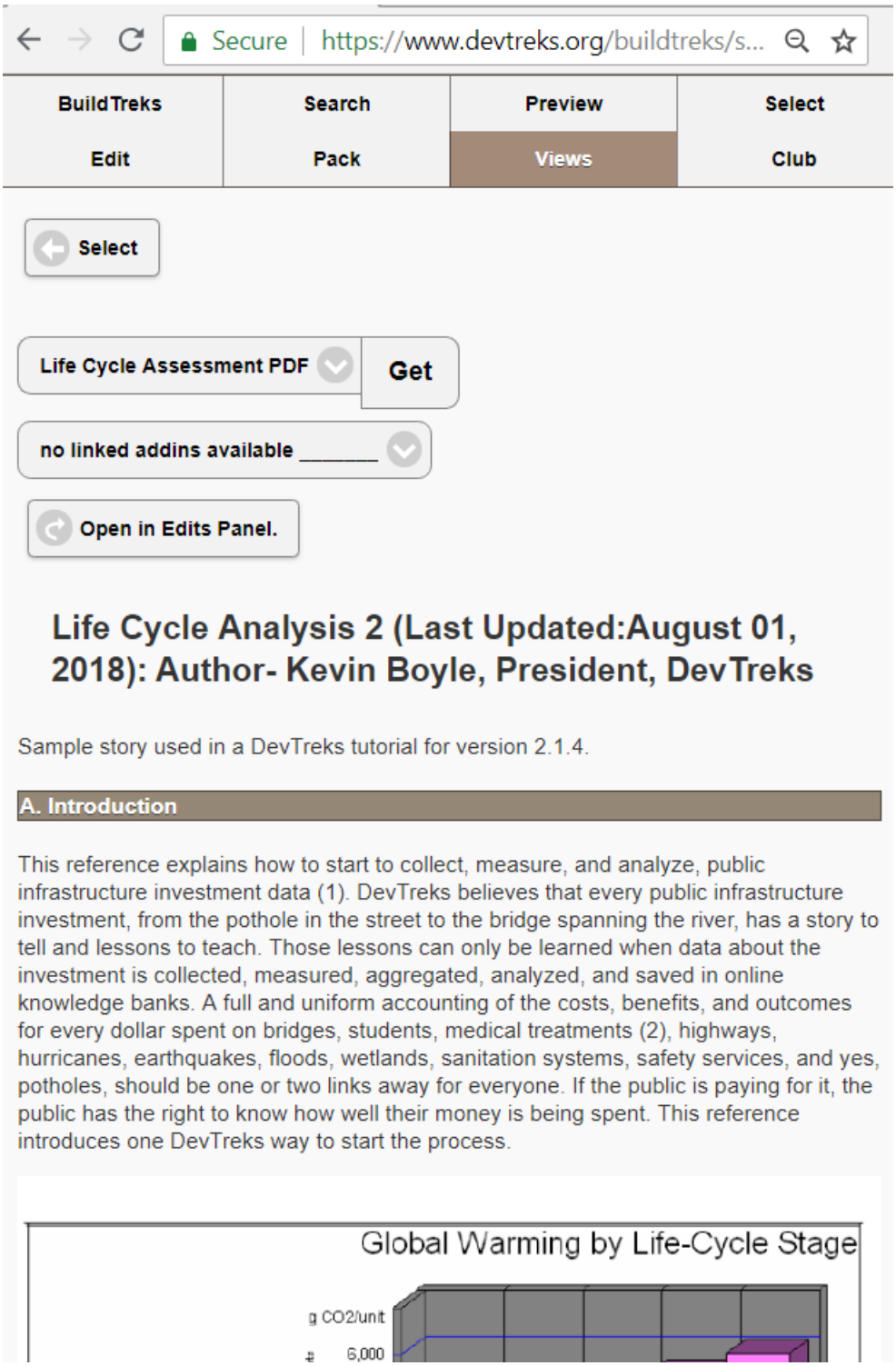
Category	Tile/Glass	Linoleum	Terrazzo	NylonTile	NylonBrdlm
Acidification--9%	0.0000	0.0000	0.0000	0.0000	0.0000
Crit. Air Pollutants--8%	0.0001	0.0001	0.0002	0.0003	0.0003
Ecolog. Toxicity--8%	0.0006	0.0007	0.0007	0.0013	0.0009
Eutrophication--9%	0.0002	0.0010	0.0007	0.0019	0.0031
Fossil Fuel Depl.--9%	0.0011	0.0006	0.0017	0.0035	0.0043
Global Warming--9%	0.0009	0.0005	0.0009	0.0018	0.0021
Habitat Alteration--8%	0.0000	0.0000	0.0000	0.0000	0.0000

Press PageDown for more results...

Figure 4.9 Viewing BEES Environmental Performance Results

J. LCA Stories (Linked Views)

All life cycle analyses should include stories that fully explain the data results and the reasons for undertaking the analysis.


Secure | https://www.devtreks.org/buildtreks/s...
BuildTreks
Search
Preview
Select
Edit
Pack
Views
Club
Select
Life Cycle Assessment PDF
Get
no linked addins available _____
Open in Edits Panel.
Life Cycle Analysis 2 (Last Updated:August 01, 2018): Author- Kevin Boyle, President, DevTreks
Sample story used in a DevTreks tutorial for version 2.1.4.
A. Introduction
This reference explains how to start to collect, measure, and analyze, public infrastructure investment data (1). DevTreks believes that every public infrastructure investment, from the pothole in the street to the bridge spanning the river, has a story to tell and lessons to teach. Those lessons can only be learned when data about the investment is collected, measured, aggregated, analyzed, and saved in online knowledge banks. A full and uniform accounting of the costs, benefits, and outcomes for every dollar spent on bridges, students, medical treatments (2), highways, hurricanes, earthquakes, floods, wetlands, sanitation systems, safety services, and yes, potholes, should be one or two links away for everyone. If the public is paying for it, the public has the right to know how well their money is being spent. This reference introduces one DevTreks way to start the process.
Global Warming by Life-Cycle Stage
g CO2/unit
6,000

K. Knowledge Bank Standards

All life cycle analyses should be entered into online knowledge banks (i.e. production servers as contrasted to development servers) that can be used to analyze the costs, benefits, and performance of public investment expenditures. That structured evidence must be passed down to future generations. These knowledge banks aggregate and analyze all of the data in a network. Future references will discuss how these knowledge banks will evolve (i.e. semantic data, forecasts) to support future decision making needs. The flexibility offered by DevTreks in documenting costs and benefits means that networks need to develop "rules" explaining the "standards" that should be followed by clubs in their network. The "standards" make it possible to build knowledge banks.

Summary and Conclusions

Clubs using DevTreks can start to carry out the basic analysis of public investment projects, programs, and technologies. Clubs can solicit help with projects that are struggling and share structured evidence explaining investment success and failure. Networks can build knowledge banks that explain why public investment projects, programs, and technologies succeed or fail and pass that knowledge down to future generations. Deficiencies with measuring social benefits can be rectified with time. The result may be governments that learn valuable lessons from costly investment mistakes, communities that make wise investments in transportation, health care, education, safety, natural resources conservation, climate change mitigation, and disaster prevention, and people who improve the sustainability of their lives and livelihoods.

Footnotes

1. Investment Analysis has a long tradition that includes more advanced analytic techniques than those used in this reference. Future releases will include some of these techniques.
2. Students and medical treatments may not sound like typical public infrastructure investments. DevTreks believes that wise public infrastructure investments can only be understood and carried out by healthy and educated citizens. The lack of human and

social capital calculators and analyzers, that can support investments in education and health, is a recognized shortfall in DevTreks. The Social Performance Analysis tutorial started to address these concerns.

3. Some parts of the health care industry (U.S. CMS) use the term “Performance Indicators” rather than “M&E Outcome Indicators”. Other parts of the industry (WHO) appear to recognize that Performance Indicators fit into the larger context of M&E.
4. The aggregated LCA element uses descriptive properties, such as name and description, from the first LCA element being aggregated. This can be a little misleading if the base LCA elements are described uniquely. For example, if the LCA element, Labor, is broken down into specific types of labor but aggregated using the same Label, the aggregated name reflects only the first type of labor. In addition, some of the aggregated numbers can be meaningless. For example, when two LCA elements, such as Materials, are entered into separate base Components that use the same LCA element Label and base element Label, their aggregated Costs will be meaningful but their aggregated Amounts will be meaningless if the Materials are not the same. Use unique LCA element Labels to distinguish LCA elements that must have meaningful aggregated Amounts. This can be particularly important when Performance Measures need to be measured using Outputs (i.e. cost per unit output) or Inputs (output per unit labor). The number of displayed LCA elements is somewhat arbitrary and may be changed in future releases.
5. Unlike NPV Analyzers, LCA Analyzers do not show Incentive Adjusted Benefits or Costs in their results (see the Benefit Cost Analysis 1 reference). DevTreks requires that Incentives be defined in LCA analysis using SubCosts or SubBenefits, rather than base element, properties. For example, rather than using an Input’s Incentive Rate or Incentive Amount Property to define an incentive, add the incentive to the Input’s SubCosts.
6. These images, with their blue motif, were not upgraded to Version 2.0.0, with its desert motif. In addition, some discrepancies were found between some of the EVM Capital Budget numbers documented in 2014 with the 2.0.0 version. The source did not change significantly in that period, so detailed investigation was not made (i.e. the 2014 documentation may have used the localhost, rather than 2016 azure, database). Several tutorials emphasize that the role of clubs and networks is to provide technical

documentation, not necessarily software developers (even if they happen to be economists).

References

References for LCA analysis can be found in the introductory Life Cycle Calculation 1 introductory reference.

References Note

We try to use references that are open access or that do not charge fees.

Improvements, Errors, and New Features

Please notify DevTreks (devtrekkers@gmail.com) if you find errors or can recommend improvements.

Video tutorials explaining this reference can be found at:

https://www.devtreks.org/commontreks/preview/commons/resourcepack/Life Cycle Analysis 2/501/none/

Appendix A. Life Cycle Analysis Examples

The current version supports the following analyses:

1. **Totals Analysis**

A Totals Analysis sums LCA elements for every base element in an analysis. No Aggregate Using or Compare Using properties are offered in the analyzers because basic totals should be documented before more complicated types of analyses are run. All analyzers run this analysis for each aggregated base element before carrying out additional calculations.

The following Totals Component analysis displays typical results. Note that the top properties (Total OC, CAP, AOH, LCC, EAA, Unit) are aggregations of the separate LCA elements (Material, Labor, Equipment).

https://www.devtrel Search

Calculation View Description
Sample analysis used in a DevTreks tutorial. v200a

Version: 1.7.0

Feedback About commercial/componentgroup/Life Cycle Cost Analysis Example 01/657/none

Component Group : Life Cycle Cost Analysis Example 01

Component Details

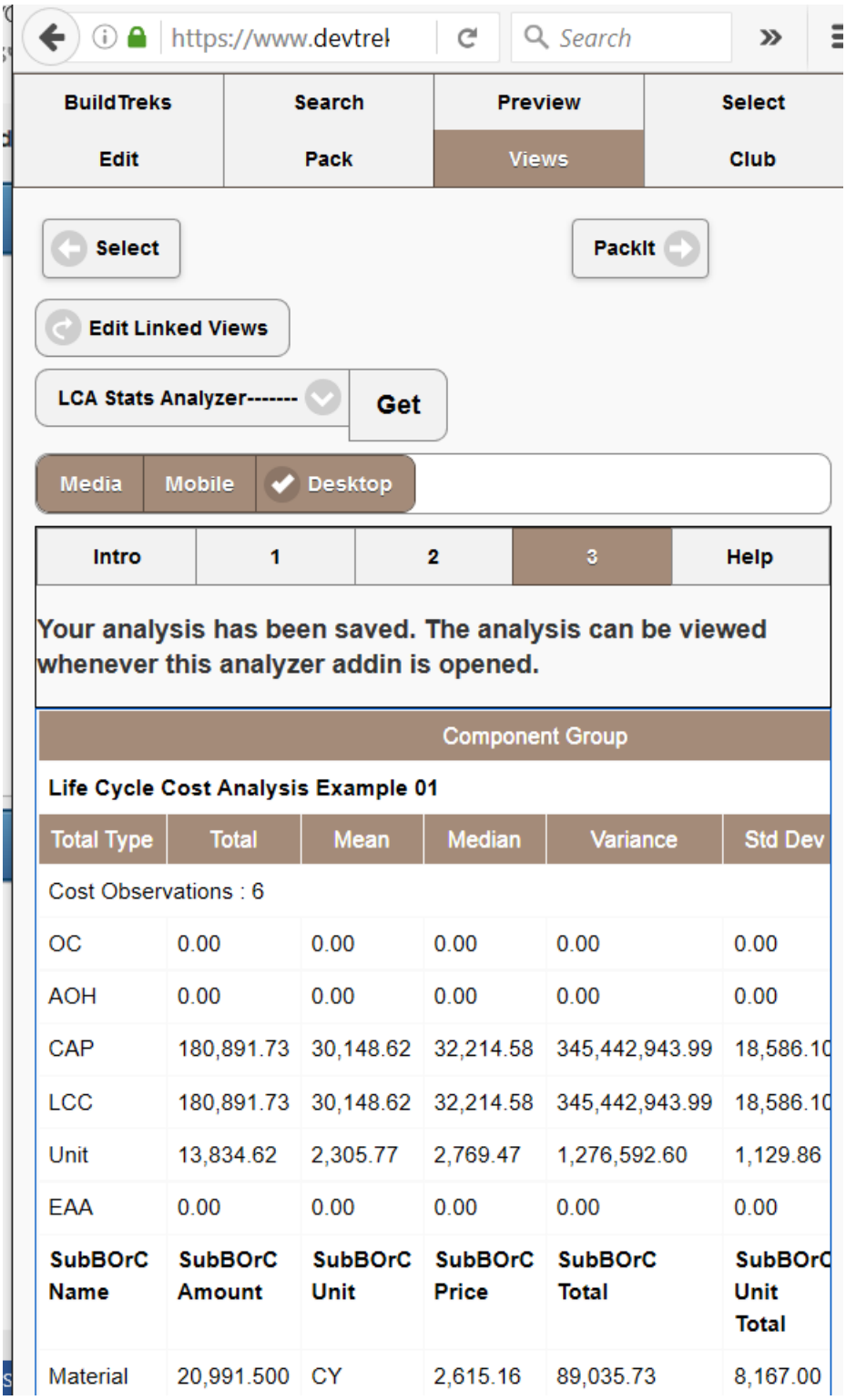
Total OC : 0.00	Total AOH : 0.00
Total CAP : 180891.73	Total LCC : 180891.73
Total EAA : 0.00	Total Unit : 13834.62
SubCost 1 Name : Material	SubCost 1 Amount : 20,991.500
SubCost 1 Unit : CY	SubCost 1 Price : 2,615.16
SubCost 1 Total : 89,035.73	SubCost 1 Unit Cost : 8,167.00
SubCost 1 Description : This cost derives from ...	SubCost 1 Label : mater01
SubCost 2 Name : Labor	SubCost 2 Amount : 25,889.000
SubCost 2 Unit : CY	SubCost 2 Price : 1,335.10
SubCost 2 Total : 88,208.90	SubCost 2 Unit Cost : 5,663.98
SubCost 2 Description : This cost derives from ...	SubCost 2 Label : labor01
SubCost 3 Name : Equipment	SubCost 3 Amount : 5,505.000
SubCost 3 Unit : CY	SubCost 3 Price : 38.79
SubCost 3 Total : 3,548.10	SubCost 3 Unit Cost : 3.55
SubCost 3 Description : This cost derives from ...	SubCost 3 Label : equip01
SubCost 4 Name : Global Warming Potential	SubCost 4 Amount : 4,950.000
SubCost 4 Unit : kg CO2 equivs	SubCost 4 Price : 0.12
SubCost 4 Total : 99.00	SubCost 4 Unit Cost : 0.10
SubCost 4 Description :	SubCost 4 Label : carbon01
SubCost 5 Name : Habitat Alteration Potential	SubCost 5 Amount : 4.950
SubCost 5 Unit : TE Species Count equivs	SubCost 5 Price : 0.00
SubCost 5 Total : 0.00	SubCost 5 Unit Cost : 0.00
SubCost 5 Description :	SubCost 5 Label : habitat01

Component : 2007 Example 01 Slab on

2. Statistics 1 Analysis

A Statistics Analysis uses the Totals calculations to measure basic statistical properties of aggregated LCA elements. Total, Median, Mean, Variance, and Standard Deviation statistics are generated for all of the LCA elements that have the same Label property.

The following Statistical Component analysis displays basic statistics associated with construction Inputs. Note that statistics are generated for the aggregate LCA element costs and benefits (Total OC, CAP, AOH, LCC, EAA, Unit) but not the separate LCA elements (Material, Labor, Equipment). Also note that the analysis takes certain cost or benefit properties, such as name and description, come from the first aggregated LCA element only (**3***).



3. Change 1 Analyses

The Change 1 Analyses use the Totals calculations to measure incremental changes in aggregated LCA elements. The NIST 135 reference demonstrates how to use these types of measurements to judge the worthiness of alternative investments. A Change by Year Analysis measures incremental changes between aggregated LCA elements that have different Years. A Change by Id Analysis measures incremental changes between LCA elements that have different Ids. A Change by AlternativeType Analysis measures incremental changes between aggregated LCA elements that have different AlternativeTypes. Changes are analyzed in ascending order (Id = 1,2,3; Year = 2000, 2001, 2002; AlternativeType = A, B, C). The first member of the sequence will be used as a "Base" element to make comparisons. The sibling sequence member immediately before the current sequence member will be used as an "x-1" (x minus 1) element to make comparisons. Gaps in the sequence, such as a missing Year, will be ignored.

Change Analysis often use a "base scenario" as the most important comparator in an analysis. Particular attention must be paid to define the base comparators in these types of analyses. Further documentation about these analyses can be found in the Change Analysis 1 reference.

The following image displays a typical result:

2009 Trailhead Improvement 01(Amount: 1.000; Date: 12/31/2009 12:00:00 AM

Cost or B Type	Total	Amount Change	Percent Change	Base Change	Base Percent Change	
Date : 12/31/2009 12:00:00 AM ; Observations: 3						
OC	0.000	0.000	0.000	0.000	0.000	
AOH	0.000	0.000	0.000	0.000	0.000	
CAP	18785.250	13855.250	281.040	13855.250	281.040	
LCC	18785.250	13855.250	281.040	13855.250	281.040	
Unit	18.785	13.855	281.040	13.855	281.040	
EAA	0.000	0.000	0.000	0.000	0.000	
SubBOrC Name	**SubBOrC Amount**	**SubBOrC Unit**	**SubBOrC Price**	**SubBOrC Total**	**SubBOrC Unit Total**	**SubBOrC Label**
Material	690.000	SF	58.65	6744.75	6.74	mater01
NPS Cost Estimate Example.						
Labor	690.000	SF	104.70	12040.50	12.04	labor01
NPS Cost Estimate Example.						
Operation						

2010 Trailhead Improvement 01(Amount: 1.000; Date: 12/31/2010 12:00:00 AM

Cost or B Type	Total	Amount Change	Percent Change	Base Change	Base Percent Change	
Date : 12/31/2010 12:00:00 AM ; Observations: 3						
OC	0.000	0.000	0.000	0.000	0.000	
AOH	0.000	0.000	0.000	0.000	0.000	
CAP	18728.850	-56.400	-0.300	13798.850	279.896	

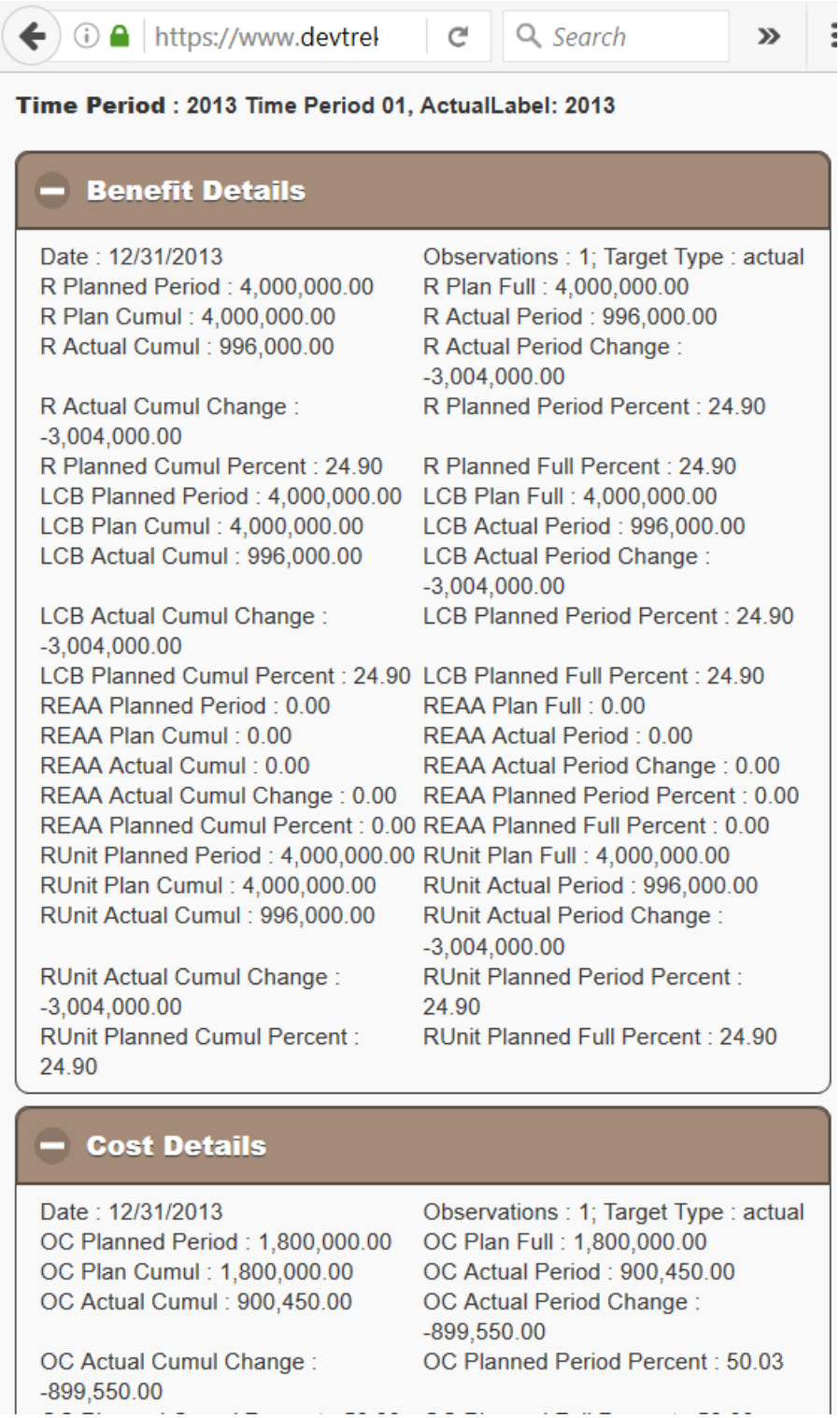
4. Progress 1 Analysis

A Progress 1 Analysis uses the Totals calculations to measure actual versus planned progress for aggregated LCA elements. The U.S. GAO (2009) emphasizes using Earned Value Management (EVM) best practices to ensure cost of work completed aligns with the value of work performed. A key requirement of EVM is to measure budget variances and scheduling variances. Budget variances measure the costs (and benefits) of work planned versus actual work completed.

Scheduling variances measure the amount, quality, and timeliness of work planned versus actual work completed. EVM uses both variances to measure changes in the value of work planned versus actual work completed. A Progress 1 Analysis measures all of these variances. DevTreks' best practices extend EVM to include Outputs (work progress), Outcomes (technical performance), Benefits (earned value), and M&E indicators (performance effectiveness).

Progress Analysis use a "benchmark scenario" as the most important comparator in an analysis. Particular attention must be paid to define the benchmark comparators in this type of analysis. Further documentation about these analyses can be found in the Earned Value Management Analysis 1 reference.

The following image displays a typical result:

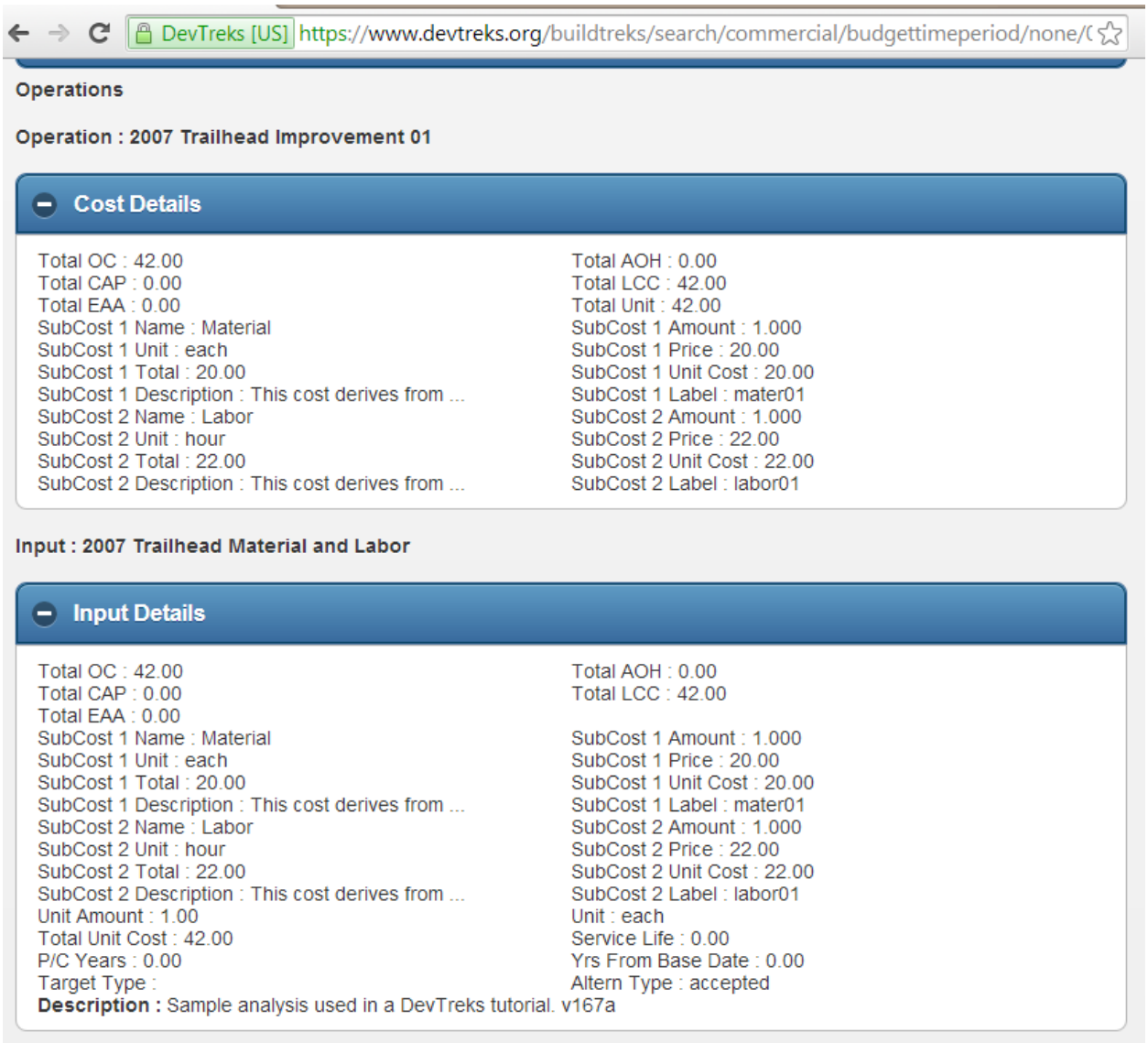


J. Multipliers (6*)

The display of totals in the LCA Analyzers reflect multiplication by base element multipliers, such as Input.Times and Outcome.Amount. SubCost and SubBenefit Amount, Total, and Total Unit, properties are also multiplied by these multipliers. Multipliers come from before-aggregated base elements.

Careful use of multipliers makes it easier to use generic “unit costs and benefits” rather than SubCosts and SubBenefits that are always tied to one specific project. That’s the same way that base element unit Input and Output prices work. Rather than being useful in only one particular project, the associated Inputs and Outputs can then be used in any project.

The following image displays an initial Input life cycle calculation in one year of an Operating Budget that has not been adjusted by any multipliers. Although not displayed, an Output in this budget also has been set similarly.



The following image shows that when the Input.OCAmount property is changed from 1 to 100, the cost properties increase proportionately.

Although not shown, the Output.Amount property was also changed from 1 to 100 and the revenue properties increased by that factor.

Operation : 2007 Trailhead Improvement 01

Cost Details

Total OC : 4200.00	Total AOH : 0.00
Total CAP : 0.00	Total LCC : 4200.00
Total EAA : 0.00	Total Unit : 4200.00
SubCost 1 Name : Material	SubCost 1 Amount : 100.000
SubCost 1 Unit : each	SubCost 1 Price : 20.00
SubCost 1 Total : 2,000.00	SubCost 1 Unit Cost : 2,000.00
SubCost 1 Description : This cost derives from ...	SubCost 1 Label : mater01
SubCost 2 Name : Labor	SubCost 2 Amount : 100.000
SubCost 2 Unit : hour	SubCost 2 Price : 22.00
SubCost 2 Total : 2,200.00	SubCost 2 Unit Cost : 2,200.00
SubCost 2 Description : This cost derives from ...	SubCost 2 Label : labor01

Input : 2007 Trailhead Material and Labor

Input Details

Total OC : 4,200.00	Total AOH : 0.00
Total CAP : 0.00	Total LCC : 4,200.00
Total EAA : 0.00	
SubCost 1 Name : Material	SubCost 1 Amount : 100.000
SubCost 1 Unit : each	SubCost 1 Price : 20.00
SubCost 1 Total : 2,000.00	SubCost 1 Unit Cost : 2,000.00
SubCost 1 Description : This cost derives from ...	SubCost 1 Label : mater01
SubCost 2 Name : Labor	SubCost 2 Amount : 100.000
SubCost 2 Unit : hour	SubCost 2 Price : 22.00
SubCost 2 Total : 2,200.00	SubCost 2 Unit Cost : 2,200.00
SubCost 2 Description : This cost derives from ...	SubCost 2 Label : labor01
Unit Amount : 1.00	Unit : each
Total Unit Cost : 4,200.00	Service Life : 0.00
P/C Years : 0.00	Yrs From Base Date : 0.00
Target Type :	Altern Type : accepted

Description : Sample analysis used in a DevTreks tutorial. v167b

The following image shows that when the Input.Times property is changed from 1 to 10, all of the Input and Operation cost properties increase proportionately. Although not shown, the Output.CompositionAmount property was changed from 1 to 2 and the the Output.Times property was changed from 1 to 5. The Outcome and Output revenue properties increased tenfold.

Operation : 2007 Trailhead Improvement 01

Cost Details

Total OC : 42000.00	Total AOH : 0.00
Total CAP : 0.00	Total LCC : 42000.00
Total EAA : 0.00	Total Unit : 42000.00
SubCost 1 Name : Material	SubCost 1 Amount : 1,000.000
SubCost 1 Unit : each	SubCost 1 Price : 20.00
SubCost 1 Total : 20,000.00	SubCost 1 Unit Cost : 20,000.00
SubCost 1 Description : This cost derives from ...	SubCost 1 Label : mater01
SubCost 2 Name : Labor	SubCost 2 Amount : 1,000.000
SubCost 2 Unit : hour	SubCost 2 Price : 22.00
SubCost 2 Total : 22,000.00	SubCost 2 Unit Cost : 22,000.00
SubCost 2 Description : This cost derives from ...	SubCost 2 Label : labor01

Input : 2007 Trailhead Material and Labor

Input Details

Total OC : 42,000.00	Total AOH : 0.00
Total CAP : 0.00	Total LCC : 42,000.00
Total EAA : 0.00	
SubCost 1 Name : Material	SubCost 1 Amount : 1,000.000
SubCost 1 Unit : each	SubCost 1 Price : 20.00
SubCost 1 Total : 20,000.00	SubCost 1 Unit Cost : 20,000.00
SubCost 1 Description : This cost derives from ...	SubCost 1 Label : mater01
SubCost 2 Name : Labor	SubCost 2 Amount : 1,000.000
SubCost 2 Unit : hour	SubCost 2 Price : 22.00
SubCost 2 Total : 22,000.00	SubCost 2 Unit Cost : 22,000.00
SubCost 2 Description : This cost derives from ...	SubCost 2 Label : labor01
Unit Amount : 1.00	Unit : each
Total Unit Cost : 42,000.00	Service Life : 0.00
P/C Years : 0.00	Yrs From Base Date : 0.00
Target Type :	Altern Type : accepted

Description : Sample analysis used in a DevTreks tutorial. v167c

The following image shows that when the Operation.Amount property is changed from 1 to 2, the Input and Operation cost properties double. Although not shown, the Outcome.Amount property was also changed from 1 to 2 resulting in the Outcome and Output revenue properties doubling.

Operations

Operation : 2007 Trailhead Improvement 01

Cost Details

Total OC : 84000.00	Total AOH : 0.00
Total CAP : 0.00	Total LCC : 84000.00
Total EAA : 0.00	Total Unit : 84000.00
SubCost 1 Name : Material	SubCost 1 Amount : 2,000.000
SubCost 1 Unit : each	SubCost 1 Price : 20.00
SubCost 1 Total : 40,000.00	SubCost 1 Unit Cost : 40,000.00
SubCost 1 Description : This cost derives from ...	SubCost 1 Label : mater01
SubCost 2 Name : Labor	SubCost 2 Amount : 2,000.000
SubCost 2 Unit : hour	SubCost 2 Price : 22.00
SubCost 2 Total : 44,000.00	SubCost 2 Unit Cost : 44,000.00
SubCost 2 Description : This cost derives from ...	SubCost 2 Label : labor01

Input : 2007 Trailhead Material and Labor

Input Details

Total OC : 84,000.00	Total AOH : 0.00
Total CAP : 0.00	Total LCC : 84,000.00
Total EAA : 0.00	
SubCost 1 Name : Material	SubCost 1 Amount : 2,000.000
SubCost 1 Unit : each	SubCost 1 Price : 20.00
SubCost 1 Total : 40,000.00	SubCost 1 Unit Cost : 40,000.00
SubCost 1 Description : This cost derives from ...	SubCost 1 Label : mater01
SubCost 2 Name : Labor	SubCost 2 Amount : 2,000.000
SubCost 2 Unit : hour	SubCost 2 Price : 22.00
SubCost 2 Total : 44,000.00	SubCost 2 Unit Cost : 44,000.00
SubCost 2 Description : This cost derives from ...	SubCost 2 Label : labor01
Unit Amount : 1.00	Unit : each
Total Unit Cost : 84,000.00	Service Life : 0.00
P/C Years : 0.00	Yrs From Base Date : 0.00
Target Type :	Altern Type : accepted

Description : Sample analysis used in a DevTreks tutorial. v167f

The following before and after images show that when the TimePeriod.Amount property is changed from 1 to 2, the Input and Operation properties don't change but the TimePeriod costs and revenues all double. Again, the before-aggregated TimePeriod multipliers are used.

Before

Time Period : 2007 Trailhead Maintenance

Benefit Details

Total Revenue : 217300.00
Total EAA : 2552.00
SubBen 1 Name : WTP Visitors to Visitor Center
SubBen 1 Unit : each
SubBen 1 Total : 127,100.00
SubBen 1 Description : This estimates the willingness to pay from visitors who visit the visitor center.
SubBen 2 Name : Nature Education Capital
SubBen 2 Unit : visitor
SubBen 2 Total : 68,200.00
SubBen 2 Description : These calculations derive from ...
SubBen 3 Name : WTP Hiking Visitor
SubBen 3 Unit : visit
SubBen 3 Total : 22,000.00
SubBen 3 Description : This estimates the willingness to pay from hiking visitors.
SubBen 4 Name : Habitat Alteration Potential
SubBen 4 Unit : TE species count equivs
SubBen 4 Total : 0.00
SubBen 4 Description : This calculation was derived by ...

Total LCB : 217300.00
Total Unit : 161256.10
SubBen 1 Amount : 4,200.000
SubBen 1 Price : 122.00
SubBen 1 Unit Cost : 93,034.10
SubBen 1 Label : wtp02
SubBen 2 Amount : 3,100.000
SubBen 2 Price : 44.00
SubBen 2 Unit Cost : 68,200.00
SubBen 2 Label : educate01
SubBen 3 Amount : 1,100.000
SubBen 3 Price : 40.00
SubBen 3 Unit Cost : 22.00
SubBen 3 Label : wtp01
SubBen 4 Amount : 1,100.000
SubBen 4 Price : 0.00
SubBen 4 Unit Cost : 0.00
SubBen 4 Label : habitat01

Cost Details

Total OC : 84924.00
Total CAP : 0.00
Total EAA : 0.00
SubCost 1 Name : Material
SubCost 1 Unit : each
SubCost 1 Total : 40,440.00
SubCost 1 Description : This cost derives from ...
SubCost 2 Name : Labor
SubCost 2 Unit : hour
SubCost 2 Total : 44,484.00
SubCost 2 Description : This cost derives from ...

Total AOH : 0.00
Total LCC : 84924.00
Total Unit : 84924.00
SubCost 1 Amount : 2,022.000
SubCost 1 Price : 40.00
SubCost 1 Unit Cost : 40,440.00
SubCost 1 Label : mater01
SubCost 2 Amount : 2,022.000
SubCost 2 Price : 44.00
SubCost 2 Unit Cost : 44,484.00
SubCost 2 Label : labor01

Outcomes

After

Time Period : 2007 Trailhead Maintenance

Benefit Details

Total Revenue : 434600.00	Total LCB : 434600.00
Total EAA : 5104.00	Total Unit : 322512.20
SubBen 1 Name : WTP Visitors to Visitor Center	SubBen 1 Amount : 4,200.000
SubBen 1 Unit : each	SubBen 1 Price : 122.00
SubBen 1 Total : 254,200.00	SubBen 1 Unit Cost : 186,068.20
SubBen 1 Description : This estimates the willingness to pay from visitors who visit the visitor center.	SubBen 1 Label : wtp02
SubBen 2 Name : Nature Education Capital	SubBen 2 Amount : 3,100.000
SubBen 2 Unit : visitor	SubBen 2 Price : 44.00
SubBen 2 Total : 136,400.00	SubBen 2 Unit Cost : 136,400.00
SubBen 2 Description : These calculations derive from ...	SubBen 2 Label : educate01
SubBen 3 Name : WTP Hiking Visitor	SubBen 3 Amount : 1,100.000
SubBen 3 Unit : visit	SubBen 3 Price : 40.00
SubBen 3 Total : 44,000.00	SubBen 3 Unit Cost : 44.00
SubBen 3 Description : This estimates the willingness to pay from hiking visitors.	SubBen 3 Label : wtp01
SubBen 4 Name : Habitat Alteration Potential	SubBen 4 Amount : 1,100.000
SubBen 4 Unit : TE species count equivs	SubBen 4 Price : 0.00
SubBen 4 Total : 0.00	SubBen 4 Unit Cost : 0.00
SubBen 4 Description : This calculation was derived by ...	SubBen 4 Label : habitat01

Cost Details

Total OC : 169848.00	Total AOH : 0.00
Total CAP : 0.00	Total LCC : 169848.00
Total EAA : 0.00	Total Unit : 169848.00
SubCost 1 Name : Material	SubCost 1 Amount : 2,022.000
SubCost 1 Unit : each	SubCost 1 Price : 40.00
SubCost 1 Total : 80,880.00	SubCost 1 Unit Cost : 80,880.00
SubCost 1 Description : This cost derives from ...	SubCost 1 Label : mater01
SubCost 2 Name : Labor	SubCost 2 Amount : 2,022.000
SubCost 2 Unit : hour	SubCost 2 Price : 44.00
SubCost 2 Total : 88,968.00	SubCost 2 Unit Cost : 88,968.00
SubCost 2 Description : This cost derives from ...	SubCost 2 Label : labor01

Outcomes

Outcome : 2007 National Park Trail Benefits 01(Amount: 2.000: Date: 12/31/2007

K. Comparative Analysis

DevTreks supports basic LCA comparative analysis for all base elements, including Inputs, Outputs, Operations, Components, Outcomes, and Budget elements. These analyses carry out the exact same calculations as non-comparative analyses. The only difference is that the results are displayed side-by-side, rather than vertically. The comparative analyses supported in DevTreks include:

1. Comparative Statistics Analysis

The following image displays the results of running a comparative Component Statistical Analysis. This analysis is run at the Component Group element level. Note that each alternative being compared is an aggregation of multiple Components that use the same Labels (Alt. 0 = 3 Components with the Label A10301A, Alt. 1 = 3 Components with the Label A10301B …).

Component	All	Alt. 0	Alt. 1	Alt. 2
Name		2009 Example 01 Slab on Grade	2010 Example 04 Slab on Grade	2011 Example 07 Slab on Grade
Label		A10301A	A10301B	A10301C
Observations		3	3	1
OC Total		0.000	0.000	0.000
OC Mean		0.000	0.000	0.000
OC Median		0.000	0.000	0.000
OC Variance		0.000	0.000	0.000
OC Std Dev		0.000	0.000	0.000
AOH Total		0.000	0.000	0.000
AOH Mean		0.000	0.000	0.000
AOH Median		0.000	0.000	0.000
AOH Variance		0.000	0.000	0.000
AOH Std Dev		0.000	0.000	0.000
CAP Total		48880.910	58587.750	21735.350
CAP Mean		16293.637	19529.250	21735.350
CAP Median		16220.100	19529.250	21735.350
CAP Variance		989598.366	1216719.303	0.000
CAP Std Dev		994.786	1103.050	0.000
LCC Total		48880.910	58587.750	21735.350
LCC Mean		16293.637	19529.250	21735.350
LCC Median		16220.100	19529.250	21735.350

The following image displays the results of running a comparative Operating Budget Statistical Analysis. This budget consists of three Time Periods with different Labels. Each Time Period finds one aggregated Outcome (aggregated using Labels) as a descendant and therefore lists 1 observation.

Time Period	All	Alt. 0	Alt. 1	Alt. 2
Name		Time Period 1	Time Period 2	Time Period 3
Label		2009	2010	2011
Benefits	**All**	**Alt. 0**	**Alt. 1**	**Alt. 2**
Observations		1.000	1.000	1.000
Benefit Total		2895.000	3027.725	14675.000
Benefit Mean		2895.000	3027.725	14675.000
Benefit Median		2895.000	3027.725	14675.000
Benefit Variance		0.000	0.000	0.000
Benefit Std Dev		0.000	0.000	0.000
LCB Total		2895.000	3027.725	14675.000
LCB Mean		2895.000	3027.725	14675.000
LCB Median		2895.000	3027.725	14675.000
LCB Variance		0.000	0.000	0.000
LCB Std Dev		0.000	0.000	0.000
REAA Total		0.000	0.000	0.000
REAA Mean		0.000	0.000	0.000
REAA Median		0.000	0.000	0.000
REAA Variance		0.000	0.000	0.000
REAA Std Dev		0.000	0.000	0.000
RUnit Total		72.375	75.693	366.875
RUnit Mean		72.375	75.693	366.875
RUnit Median		72.375	75.693	366.875

2. Comparative Change Analysis

The following image displays the results of running a comparative Component Change by AlternativeType Analysis. This analysis is run at the Component Group element level and is the same data displayed for the comparative Statistics. Note that each alternative being compared is an aggregation of multiple Components that use the same AlternativeType (Alt. 0 = 2 Components with Alt A, Alt. 1 = 2 Components with Alt B …). The number of observations in this type of analysis can match the number of observations in the comparative Statistical Analysis by keeping the same Label-AlternativeType relation.

Component	All	Alt. 0	Alt. 1	Alt. 2
Name		2009 Example 01 Slab on Grade	2010 Example 03 Slab on Grade	2011 Example 05 Slab on Grade
Date		12/31/2009 12:00:00 AM	12/31/2010 12:00:00 AM	12/31/2011 12:00:00 AM
Observations		2	2	3
Alternative		A	B	C
OC Total		0.000	0.000	0.000
OC AmountChange		0.000	0.000	0.000
OC PercentChange		0.000	0.000	0.000
OC BaseChange		0.000	0.000	0.000
OC BasePercentChange		0.000	0.000	0.000
AOH Total		0.000	0.000	0.000
AOH AmountChange		0.000	0.000	0.000
AOH PercentChange		0.000	0.000	0.000
AOH BaseChange		0.000	0.000	0.000
AOH BasePercentChange		0.000	0.000	0.000
CAP Total		31557.760	35749.350	61896.900
CAP AmountChange		31557.760	4191.590	26147.550
CAP PercentChange		0.000	13.282	73.141
CAP BaseChange		0.000	4191.590	30339.140
CAP BasePercentChange		0.000	13.282	96.138

The following image displays the results of running a comparative Capital Budget Change by Alternative Analysis. This budget consists of three Budgets with different AlternativeTypes. Note that Budget 2 finds a base comparator but not an x-1 comparator. Budget 3 finds both comparators.

Investment Group : Public Infrastructure Analysis Example ; 8/16/2013 12:00:00 AM				
Investment	All	Alt. 0	Alt. 1	Alt. 2
Name		Infrastructure Investment 01	Infrastructure Investment 02	Infrastructure Investment 03
Date		11/5/2013 12:00:00 AM	11/5/2013 12:00:00 AM	11/5/2013 12:00:00 AM
Label		NPS1010	NPS1011	NPS1012
Benefits	All	Alt. 0	Alt. 1	Alt. 2
Observations		1	1	1
Alternative		A	B	C
Benefit Total		20597.725	15448.293	10298.862
Benefit AmountChange		0.000	0.000	-5149.431
Benefit PercentChange		0.000	0.000	-33.333
Benefit BaseChange		0.000	-5149.431	-10298.862
Benefit BasePercentChange		0.000	-25.000	-50.000
LCB Total		20597.725	15448.293	10298.862
LCB AmountChange		0.000	0.000	-5149.431
LCB PercentChange		0.000	0.000	-33.333
LCB BaseChange		0.000	-5149.431	-10298.862
LCB BasePercentChange		0.000	-25.000	-50.000
REAA Total		0.000	0.000	0.000
REAA AmountChange		0.000	0.000	0.000
REAA PercentChange		0.000	0.000	0.000
REAA BaseChange		0.000	0.000	0.000
REAA BasePercentChange		0.000	0.000	0.000

The following image displays a comparison of three Time Periods that are descendants of the three Budgets shown in the previous image. Each Budget has three Time Periods. Each Budget's Time Periods were given distinct Labels and distinct AlternativeTypes. The descendants will line up correctly when their Label properties have been set equal to one another. If more than one Time Period within a Budget has the same AlternativeType, the Time Periods will be aggregated together and the number of Observations will reflect the aggregation. Similarly if more than one Time Period within a Budget has the same Label, and the analysis is run using the Aggregate by

Label option, aggregation occurs and the number of Observations reflects the elements being aggregated. In many instances, these aggregations are desirable because the comparisons become condensed and easier to interpret.

Time Period	All	Alt. 0	Alt. 1	Alt. 2
Name		2009 Period 01	2009 Time Period	2009 Time Period
Date		12/31/2009 12:00:00 AM	12/31/2009 12:00:00 AM	12/31/2009 12:00:00 AM
Label		2009	2009	2009
Benefits	**All**	**Alt. 0**	**Alt. 1**	**Alt. 2**
Observations		1	1	1
Alternative		A	A	A
Benefit Total		2895.000	2171.250	1447.500
Benefit AmountChange		0.000	0.000	-723.750
Benefit PercentChange		0.000	0.000	-33.333
Benefit BaseChange		0.000	-723.750	-1447.500
Benefit BasePercentChange		0.000	-25.000	-50.000
LCB Total		2895.000	2171.250	1447.500
LCB AmountChange		0.000	0.000	-723.750
LCB PercentChange		0.000	0.000	-33.333
LCB BaseChange		0.000	-723.750	-1447.500
LCB BasePercentChange		0.000	-25.000	-50.000
REAA Total		0.000	0.000	0.000
REAA AmountChange		0.000	0.000	0.000
REAA PercentChange		0.000	0.000	0.000
REAA BaseChange		0.000	0.000	0.000
REAA BasePercentChange		0.000	0.000	0.000

3. Comparative Progress Analysis (6*)

The following image displays the results of running a comparative Outcome Progress 1 Analysis. This analysis is run at the Outcome Group element level. The comparisons are being made

between a planned (benchmark) and actual quarterly Outcome. How can you tell which planned and actual Outcomes are being compared? Comparisons are made between elements with the same Labels in sequential date order. All of the planned Outcomes are placed in sequential date order and the first actual Outcome will be compared with the first planned Outcome with the same Label. The comparisons can be easier to interpret with the careful use of Names, Dates, Labels, and Target Types. In this example, the Q1 Actual can appear directly after the corresponding Q1 Planned by reversing their dates.

Outcome Group : Earned Value Management Examples ; A10								
Outcome	All	Alt. 0	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
Name		2013, Q1 RR Track Actual	2013, Q1 RR Track Planned	2013, Q2 RR Track Planned	2013, Q2 RR Track Actual	2013, Q3 RR Track Planned	2013, Q3 RR Track Actual	2013, Q4 RR Track Planned
Date		3/30/2013 12:00:00 AM	3/31/2013 12:00:00 AM	6/30/2013 12:00:00 AM	6/30/2013 12:00:00 AM	9/30/2013 12:00:00 AM	9/30/2013 12:00:00 AM	12/30/2013 12:00:00 AM
Label		A1010	A1010	A1010	A1010	A1010	A1010	A1010
Observations		1	1	1	1	1	1	1
Target		actual	benchmark	benchmark	actual	benchmark	actual	benchmark
R Plan Period		991000.000	991000.000	991000.000	991000.000	991000.000	991000.000	991000.000
R Plan Full		3964000.000	3964000.000	3964000.000	3964000.000	3964000.000	3964000.000	3964000.000
R Plan Cumul		991000.000	991000.000	1982000.000	1982000.000	2973000.000	2973000.000	3964000.000
R Actual Period		330003.000	0.000	0.000	330003.000	0.000	330003.000	0.000
R Actual Cumul		330003.000	0.000	0.000	660006.000	0.000	990009.000	0.000
R Actual Period Change		-660997.000	0.000	0.000	-660997.000	0.000	-660997.000	0.000
R Actual Cumul Change		-660997.000	0.000	0.000	-1321994.000	0.000	-1982991.000	0.000
R Plan P Percent		33.300	0.000	0.000	33.300	0.000	33.300	0.000
R Plan C Percent		33.300	0.000	0.000	33.300	0.000	33.300	0.000
R Plan Full Percent		8.325	0.000	0.000	16.650	0.000	24.975	0.000

The following image displays the results of running a comparative Operation Budget Progress 1 Analysis. This budget consists of one planned and one actual Budget, each holding one Time Period. The actual column shows that the actual value of the work completed is seriously behind the planned value of the work.

Budget Group : Life Cycle Earned Value Management Examples ; 11/4/2013 12:00:00 AM			
Budget	All	Alt. 0	Alt. 1
Name		EVM 01 Planned Budget	EVM 02 Actual Budget
Date		11/6/2013 12:00:00 AM	11/6/2013 12:00:00 AM
Label		A100	A100
Benefits	All	Alt. 0	Alt. 1
Observations		1	1
Target		benchmark	actual
R Plan Period		991000.000	991000.000
R Plan Full		3964000.000	3964000.000
R Plan Cumul		3964000.000	2973000.000
R Actual Period		0.000	330003.000
R Actual Cumul		0.000	990009.000
R Actual Period Change		0.000	-660997.000
R Actual Cumul Change		0.000	-1982991.000
R Plan P Percent		0.000	33.300
R Plan C Percent		0.000	33.300
R Plan Full Percent		0.000	24.975
LCB Plan Period		991000.000	991000.000
LCB Plan Full		3964000.000	3964000.000
LCB Plan Cumul		3964000.000	2973000.000
LCB Actual Period		0.000	330003.000
LCB Actual Cumul		0.000	990009.000

The following image displays what the descendent elements look like for the same Operating Budget Progress 1 Analysis. Each of the four quarters being compared in the base and actual budgets will line up side by side if their Dates, Target Types, and Labels have been set correctly.

SubCost 3 Total		85.57	64.18
SubCost 3 Total Per Unit		85.57	64.18
Operation	All	Alt. 0	Alt. 1
Name		2013 Rail Road Maintenance, Q3 Planned	2013 Rail Road Maintenance, Q3 Actual
Date		9/30/2013 12:00:00 AM	9/30/2013 12:00:00 AM
Label		0120	0120
Costs	All	Alt. 0	Alt. 1
Observations		1	1
Target		benchmark	actual
OC Plan Period		830.000	830.000
OC Plan Full		3320.000	3320.000
OC Plan Cumul		2490.000	2490.000
OC Actual Period		0.000	415.000
OC Actual Cumul		0.000	2282.500
OC Actual Period Change		0.000	-415.000
OC Actual Cumul Change		0.000	-207.500
OC Plan P Percent		0.000	50.000
OC Plan C Percent		0.000	91.667
OC Plan Full Percent		0.000	68.750
AOH Plan Period		20.570	20.570
AOH Plan Full		82.280	82.280
AOH Plan Cumul		61.710	61.710