



DevTreks –social budgeting that improves lives and livelihoods

Benefit Cost Analysis 1

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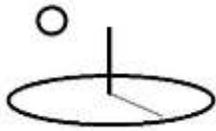
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Version: DevTreks 2.2.0

A. Introduction

This reference explains how to start to collect, measure, and analyze, basic benefit and cost data (1*). DevTreks believes that every production process, business practice, and technology, from growing corn in the field to replacing a hip in the hospital, has a story to tell and lessons to teach. Those lessons can only be learned when cost and benefit data about production, business practice, and technology is collected, measured, aggregated, analyzed, explained, and saved in online knowledge banks. A full, uniform, and accurate accounting of the costs, benefits, and outcomes for every dollar spent on crops, livestock, malnutrition improvements, medical treatments, conservation practices, and best or worse business practices, should be one or two links away for everyone. If a business owner, lender, nonprofit member, government official, worker, or citizen, needs to make a decision involving costs, benefits, and performance, they should have ready access to the best data available. This reference introduces another DevTreks way to build these knowledge banks.

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B. Data URLs

The Construction Analysis 1, Health Care Analysis 1, Malnutrition Analysis 1, Ag Production Analysis 1, and Work Breakdown Structures, tutorials demonstrate how basic cost and benefit data can be structured to support the analyses shown in this reference.

The Analyzers demonstrated in this reference can be found at the following URIs:

[https://www.devtreks.org/agtreks/preview/crops/linkedviewgroup/Benefit Cost 1 Analyzers/60/none/](https://www.devtreks.org/agtreks/preview/crops/linkedviewgroup/Benefit%20Cost%20Analyzers/60/none/)

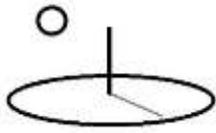
[https://localhost:5001/agtreks/preview/crops/linkedviewgroup/Benefit Cost Analyzers/56/none/](https://localhost:5001/agtreks/preview/crops/linkedviewgroup/Benefit%20Cost%20Analyzers/56/none/)

The following URIs contain sample data sets that display the results of running NPV analyzers. These data sets were structured for the purpose of testing the analyzers (i.e. they don't all use real WBSs). The data is fictitious and no weight should be assigned to the absolute numbers – pay attention to the aggregation techniques only.

Many of these data sets also contain Life Cycle Analysis (LCA) calculators and analyzers. We recommend confirming, and understanding, the differences between the two techniques. The most prominent difference occurs when the data being analyzed does not use LCA calculators and analyzers for every input and output –LCA Analysis only analyzes the results generated by LCA calculations. The NPV tutorials explain that Operating Budgets should only include operating and allocated overhead costs –they shouldn't include the capital costs contained in some of these examples.

- **Components URI:**

Construction Examples (Reconstruction Science Club)



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<https://www.devtreks.org/buildtreks/preview/commercial/componentgroup/Life Cycle Cost Analysis Example 01/657/none/>

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

- **Operations URI:**

Agricultural Examples (Iowa Corn and Soybean Club)

<https://www.devtreks.org/agtreks/preview/crops/operationgroup/Nutrient Management, Nashua corn and beans research plots, N application/326/none>

<https://localhost:5001/agtreks/preview/crops/operationgroup/Nutrient Management, Nashua corn and beans research plots, N application/326/none>

Construction Examples (Reconstruction Science Club)

<https://www.devtreks.org/buildtreks/preview/commercial/operationgroup/NPS Trailhead Life Cycle Cost Group/757/none/>

<https://localhost:5001/buildtreks/preview/residential/operationgroup/National Park Trailhead Improvement Group/760/none>

- **Outcomes URI:**

Construction Examples (Reconstruction Science Club)

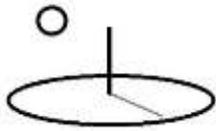
<https://www.devtreks.org/buildtreks/preview/commercial/outcomegroup/National Park Recreation Outcomes/33/none/>

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

- **Capital Budgets URI:**

Construction Examples (Reconstruction Science Club)

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



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

- **Operating Budgets URI:**

Agricultural Examples (Iowa Corn and Soybean Club)

<https://www.devtreks.org/agtreks/preview/crops/budget/Plot 01/273071700/none>

<https://localhost:5001/agtreks/preview/crops/budget/Plot 01, v1-2-0/273071700/none>

Construction Examples (Reconstruction Science Club)

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

<https://localhost:5001/buildtreks/preview/commercial/budget/Public Infrastructure Budget 01/273083903/none>

- **Multimedia URI:**

<https://www.devtreks.org/agtreks/preview/crops/resourcepack/Agricultural Production, Capital Investment Media Pack/260/none/>

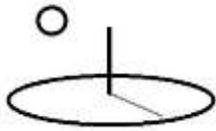
- **Story URI:**

<https://www.devtreks.org/agtreks/preview/crops/linkedviewpack/Randomized complete crop block, tillage treatment analysis, 1990-1992 crops/32/none>

<https://www.devtreks.org/agtreks/preview/crops/linkedviewgroup/Economics/13/none/>

Examples of Progress Analysis data sets can be found in the Earned Value Management 1 reference. Examples of Input and Output Price Analysis data sets can be found in the Price Analysis 1 reference.

c. **Work Breakdown Structure (WBS)**



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The construction data analyzed in this reference uses the UNIFORMAT WBS. Some output data was able to use that WBS as well. The remaining data was classified using fictitious WBSs. All of the data used in these analyses were aggregated using these WBS Labels.

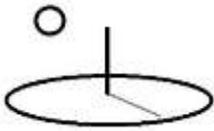
D. Domain Calculators versus Generic Calculators

Readers with a deep understanding of fields such as natural resources conservation, health care, malnutrition analysis, food security, safety efficacy, or human capital performance, will recognize that the generic cost and benefit tools explained in the NPV, LCA, Monitoring and Evaluation (M&E), and Resource Stock, tutorials, fail to capture the full depth of the costs and benefits associated with their field. They are right. Several DevTreks’ calculators, including Machinery, Irrigation, and Malnutrition, demonstrate how to integrate domain-specific knowledge with these more generic tools. The Social Performance tutorial demonstrates how to use generic algorithms to run domain-specific calculations.

E. Net Present Value (NPV) Calculations

The Net Present Value 1 and 2 tutorials document the base NPV calculations that will be aggregated and analyzed in this reference. A typical NPV calculation result is displayed in the following image. These analyzers only use the “Annual”, or “Ann”, totals, which reflect annual amortized costs (i.e. see the dairy heifer, alfalfa, or almonds examples in the Net Present Value 1 reference). Discounted cash flows (the Totals column) are not analyzed. Cash flows were not included because the resultant quantity of data is hard to interpret and the “resource flows” data gives a truer picture of net benefits.

The Input, Output, Operation, Component, Outcome, Operating Budget, Capital Budget, elements in these calculations and analyses are referred to as base elements throughout these tutorials.



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[Feedback About crops/budget/2- Corn Soybean Rotation/273071632/none](#)

Budget Group : Operating Budgets, Common Agricultural Examples

+ Budget Group Details

Budget : 2- Corn Soybean Rotation

+ Budget Details

Total Ben : 545.91	Ann Ben : 545.91
Total OC Cost : 265.53	Ann OC Cost : 265.53
Net OC Profits : 280.38	Ann Net OC Profits : 280.38
Total AOH Cost : 255.81	Ann AOH Cost : 255.81
Net AOH Profits : 24.57	Ann Net AOH Profits : 24.57
Total CAP Cost : 0.00	Ann CAP Cost : 0.00
Net Profits : 24.57	Ann Net Profits : 24.57
Incent Ben : 545.91	Ann Incent Ben : 545.91
Incent Cost : 521.34	Ann Incent Cost : 521.34
Net Incent Cost : 24.57	Net Ann Incent Profit : 24.57
Equiv Ann Ann : 13.21	

+ Time Period : Corn

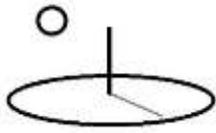
+ Time Period : Soybeans

[Feedback About crops/budget/2- Corn Soybean Rotation/273071632/none](#)

Dataset: [2- Corn Soybean Rotation IRI](#) This operating budget demonstrates best practices for conducting commodity cost and return estimates for typical crop rotations,

Search IRIs:
https://www.devtreks.org/agtreks/linkedviews/crops/budget/2-Corn_Soybean_Rotation/273071632/none

F. NPV Analyses



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Separate NPV analyzers are available for all base elements. The Calculator and Analyzer 1 reference documents how all DevTreks' Analyzers work. The Analysis Type property of NPV Analyzers is used to specify the type of analysis to run. The Performance Analysis 1 references explain how to use the results of these analyses to make decisions involving costs, benefits, and performance.

Analysis Result Properties

The results of running analyses are displayed using the following basic properties for Operations, Components, Outcomes, Operating Budgets, and Capital Budgets (which are defined more thoroughly in the Net Present Value 1 reference):

Operation, Component, or Budget Cost Properties

Total AMOC: Total Annual Operating Costs

Total AMAOH: Total Annual Allocated Overhead Costs

Total AMCAP: Total Annual Capital Costs

Total AMTotal: Total Annual Costs

Total AMIncent: Total Annual Incentive-Adjusted Costs

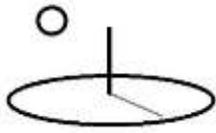
Outcome or Budget Benefit Properties

Total AMR: Total Annual Benefits

Total AMRIncent: Total Annual Incentive-Adjusted Benefits

Output Properties (2*)

Total RAmount: Total Output Amount



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Total RPrice: Total Output Price

Total RCompositionAmount: Total Composition Amount (3*)

Budget Net Properties

Total AMNet: Total Annual Net Returns

Total AMIncentNet: Total Annual Incentive-Adjusted Net Returns (4*)

Input and Output Properties

The Price Analysis 1 reference documents the properties used in Input and Output Price Analysis.

Multipliers

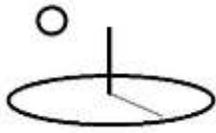
Multipliers, such as an Operation Amount, are not used directly in these analyzers. The base NPV calculations that are aggregated are multiplied by the standard multipliers found in most base elements.

G. NPV Analyzers

The current version supports the following analyzers:

1. Totals Analysis

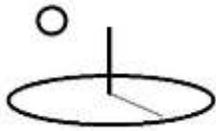
A Totals Analysis sums NPV calculations for all base elements in an analysis. All analyzers run this analysis for each aggregated base element before carrying out additional calculations. With the exception of Inputs and Outputs, the initial values used in all analyzers derive from NPV calculator results. No separate NPV calculations are run in any analyzer (unlike the LCA Analyzers which do run Life Cycle calculations first). So why duplicate the NPV calculator



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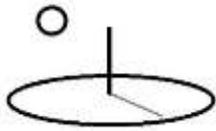
results in this particular analysis? The results of this analysis are more compact and can be aggregated using an analyzer’s standard aggregators.

The following Outcome Totals Analyses displays typical results. Note that these properties coincide with the “Annuals” columns found in NPV calculator results (see the Net Present Value 1 tutorial). Compare the level of detail in these results versus a LCA Totals Analysis. These analyzers offer a much more compact analysis of costs and benefits compared to the LCA Analyzers or the base NPV calculators. They are also much faster to complete. Note that the Outcome includes aggregated Output Price and Amount properties.



Outcome Group							
Life Cycle Outcome Examples							
2012 NIST 135 style Output 2	each	481997.36	29.75	each	46.8125	485984.969	485984.969
Outcome							
2008 NPS LCB Example 01							
Name	Unit	Price	Amount	Compos Unit	Compos Amount	Total Benefit	Total Incentive
2008 NPS Visitor Trailhead WTP	each	649.2	5	each	6	1186.843	1186.843
Name	Unit	Price	Amount	Compos Unit	Compos Amount	Total Benefit	Total Incentive
Outputs							
2008 Natural Resource Asset Improvements	each	334.2	1	each	1	338.953	338.953
2008 NPS Non-Visitor Trailhead WTP	each	212	2	each	1	430.03	430.03
2008 NPS Visitor Trailhead WTP	each	103	2	each	4	417.86	417.86
Outcome							
2008 NPS LCB Example 02							
Name	Unit	Price	Amount	Compos Unit	Compos Amount	Total Benefit	Total Incentive
2008 NPS Visitor Trailhead WTP	each	649.2	3	each	6	873.449	873.449
Name	Unit	Price	Amount	Compos Unit	Compos Amount	Total Benefit	Total Incentive
Outputs							
2008 Natural Resource Asset Improvements	each	334.2	1	each	1	338.953	338.953

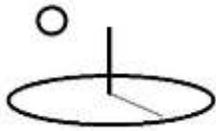
The following Operation Total Analysis shows that unlike Outputs, the Input prices and amounts are not being aggregated in the Operation totals. Do you know why?



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Operation Group									
Reconstruction Operation Group OG125 12/7/2013 12:00:00 AM									
TAMOC	TAMAOH	TAMCAP	TAMCost	TAMIncent					
5615.925	139.181	0	5755.106	5755.106					
Operation									
2013 Rail Road Maintenance, Q4 Planned 0120 12/31/2013 12:00:00 AM									
TAMOC	TAMAOH	TAMCAP	TAMCost	TAMIncent					
832.047	20.621	0	852.668	852.668					
TAMOC	TAMAOH	TAMCAP	TAMCost	TAMIncent	TOC P	TOC Q	TAOH P and Q	TCAP P	TCAP Q
Input: 2013 RR Track -Op Bud- EVM3 12/1/2013 12:00:00 AM									
566.393	4.852	0	571.245	571.245	565	1	4.84;1	0	1
Input: 2013 RR Track Site Prep -Op Bud- EVM4 12/1/2013 12:00:00 AM									
265.654	15.769	0	281.423	281.422	265	1	15.73;1	0	1
Operation									
2013 Rail Road Maintenance, Q1 Planned 0120 3/30/2013 12:00:00 AM									
TAMOC	TAMAOH	TAMCAP	TAMCost	TAMIncent					
831.979	20.619	0	852.598	852.598					
TAMOC	TAMAOH	TAMCAP	TAMCost	TAMIncent	TOC P	TOC Q	TAOH P and Q	TCAP P	TCAP Q
Input: 2013 RR Track -Op Bud- EVM3 3/1/2013 12:00:00 AM									
566.347	4.852	0	571.199	571.198	565	1	4.84;1	0	1
Input: 2013 RR Track Site Prep -Op Bud- EVM4 3/1/2013 12:00:00 AM									
265.632	15.767	0	281.399	281.399	265	1	15.73;1	0	1

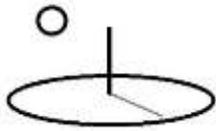
The following Capital Budget Total Analysis shows how Benefits and Costs appear in budgets. Again, note the Output Price and Amount aggregation. Why are Outputs being aggregated, while Inputs are not? Think of a typical crop or livestock budget, or basic cost effectiveness analysis.



Investment Group : Public Infrastructure Analysis Example NPS10 8/16/2013 12:00:00 AM							
Benefits							
Output Name	Unit	Price	Amount	Compos Unit	Compos Amount	Total Benefit	Total Incentive
2011 NPS Visitor Trailhead WTP	each	14673	68.25	each	107.4375	14963.921	14963.921
Costs and Nets							
Total OC	Total AOH	Total CAP	Total Cost	Net Returns	Total Incent	Net Incent Returns	
0	0	290963.488	290963.488	-275999.567	290963.488	-275999.567	
Investment : Infrastructure Investment 01 NPS1010 12/5/2013 12:00:00 AM							
Benefits							
Output Name	Unit	Price	Amount	Compos Unit	Compos Amount	Total Benefit	Total Incentive
2011 NPS Visitor Trailhead WTP	each	4891	22.75	each	35.8125	6650.632	6650.632
Costs and Nets							
Total OC	Total AOH	Total CAP	Total Cost	Net Returns	Total Incent	Net Incent Returns	
0	0	129317.106	129317.106	-122666.474	129317.106	-122666.474	
Time Period : 2009 Period 01 2009 12/31/2009 12:00:00 AM							
Benefits							
Output Name	Unit	Price	Amount	Compos Unit	Compos Amount	Total Benefit	Total Incentive
2009 NPS Visitor Trailhead WTP	each	1358	6	each	9	1822.558	1822.558

2. Statistics 1 Analysis

A Statistics Analysis uses the Totals calculations to measure basic statistical properties of aggregated base elements. Total, Median, Mean, Variance, and Standard Deviation statistics are generated for all of the base elements that use the standard aggregators.



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The following Component Statistical Analysis displays basic statistics associated with construction Components. Note that these Components have zero operating costs and allocated overhead costs. Closer inspection of the underlying NPV calculations will reveal that this analysis is measuring discounted cash flows.

Component Group									
Life Cycle Comp Analysis Examples A10 12/5/2013 12:00:00 AM									
Total Type	Total	Mean	Median	Variance	Std Dev				
Cost Observations : 3.000									
OC	0.000	0.000	0.000	0.000	0.000				
AOH	0.000	0.000	0.000	0.000	0.000				
CAP	133003.649	44334.550	36800.669	286418886.593	16923.915				
Total Cost	133003.649	44334.550	36800.669	286418886.593	16923.915				
Incentives	133003.649	44334.550	36800.669	286418886.593	16923.915				
Component									
2009 Example 01 Slab on Grade A10301A 12/31/2009 12:00:00 AM									
Total Type	Total	Mean	Median	Variance	Std Dev				
Cost Observations : 2.000									
OC	0.000	0.000	0.000	0.000	0.000				
AOH	0.000	0.000	0.000	0.000	0.000				
CAP	32485.813	16242.907	16242.907	412587.104	642.329				
Total Cost	32485.813	16242.907	16242.907	412587.104	642.329				
Incentives	32485.813	16242.907	16242.907	412587.104	642.329				
TAMOC	TAMAOH	TAMCAP	TAMCost	TAMIncent	TOC P	TOC Q	TAOH P and Q	TCAP P	TCAP Q
Input: NPS 2009, Concrete Waste Factor 10% 03.30.53 1/12/2009 12:00:00 AM									
0.000	0.000	255.602	255.602	255.602	0	0	0;0	248.3	1
Input: NPS 2009, Edge form Included in std- foundation 03.11.13 1/12/2009 12:00:00 AM									

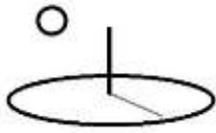
The following Outcome Statistical Analysis displays basic statistics associated with natural resources Outputs. Note the aggregated Output properties, including Prices and Amounts. Also note that multiple Outcomes, with multiple Outputs, are being aggregated. If the aggregated



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Outputs are so dissimilar that they can't be aggregated, the Price and Amount aggregated properties may not be meaningful.

Outcome	All	Alt. 0	Alt. 1	Alt. 2
Name		2007 National Park Trail Benefits 01	2007 National Park Trail Benefits 02	2011 National Park Trail Benefits 03
Label		NPS1001A	NPS1001B	NPS1001C
Observations		3.00	3.00	1.00
Benefit Total		296,397.79	288,891.04	102,000.09
Benefit Mean		98,799.26	96,297.01	102,000.09
Benefit Median		104,967.42	95,859.32	102,000.09
Benefit Variance		220,033,856.30	359,182,133.45	0.00
Benefit Std Dev		14,833.54	18,952.10	0.00
R Incent Total		296,397.79	288,891.04	102,000.09
R Incent Mean		98,799.26	96,297.01	102,000.09
R Incent Median		104,967.42	95,859.32	102,000.09
R Incent Variance		220,033,856.30	359,182,133.45	0.00
R Incent Std Dev		14,833.54	18,952.10	0.00
Output Q Total		6,300.00	6,100.00	2,000.00
Output Q Mean		2,100.000	2,033.333	2,000.000
Output Q Median		0.000	0.000	2,000.000
Output Q Variance		13,230,000.000	12,403,333.333	0.000
Output Q Std		3,637.307	3,521.837	0.000

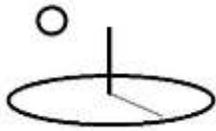


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The following Operating Budget Statistical Analysis displays basic statistics associated with public infrastructure investments.

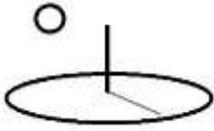
Time Period : 2013 Planned Time Period none 12/31/2013 12:00:00 AM						
Total Type	Total	Mean	Median	Variance	Std Dev	
Benefit Observations : 2.000						
Benefits	3986194.128	1993097.064	1993097.064	7944871813050.840	2818664.899	
Incentives	3986194.128	1993097.064	1993097.064	7944871813050.840	2818664.899	
Amount	8	4.000	4.000	32.000	5.657	
Composition Amount	8	4.000	4.000	32.000	5.657	
Price	3964000	1982000.000	1982000.000	7856648000000.000	2802971.281	
Cost Observations : 2.000						
OC	3366.025	1683.013	1683.013	5665062.150	2380.139	
AOH	83.421	41.711	41.711	3479.532	58.988	
CAP	0.000	0.000	0.000	0.000	0.000	
Total Cost	3449.447	1724.724	1724.724	5949342.303	2439.127	
Net	3982744.681	1991372.341	1991372.341	7958627927769.390	2821104.026	
Incentives	3449.447	1724.724	1724.724	5949342.303	2439.127	
Net Incentive	3982744.681	1991372.3405	1991372.341	7958627927769.390	2821104.02639984	
Total Type	Total	Mean	Median	Variance	Std Dev	
Outcome 2013, Q1 RR Track Planned A1010 3/31/2013 12:00:00 AM						
Benefit Observations : 4.000						
Benefits	3986194.128	996548.532	996548.532	0.000	0.000	
Incentives	3986194.128	996548.532	996548.532	0.000	0.000	
Amount	8	2.000	0.000	0.000	0.000	

The following Capital Budget Statistical Analysis displays basic statistics associated with public infrastructure investments.



Investment : Infrastructure Investment 01 NPS1010 12/5/2013 12:00:00 AM						
Total Type	Total	Mean	Median	Variance	Std Dev	
Benefit Observations : 3.000						
Benefits	6650.632	2216.877	1822.558	647986.821	804.976	
Amount	22.75	7.583	6.750	4.521	2.126	
Composition Amount	35.8125	11.938	9.000	37.762	6.145	
Price	4891	1630.333	1358.000	222496.333	471.695	
Incentives	6650.632	2216.877	1822.558	647986.821	804.976	
Cost Observations : 3.000						
OC	0.000	0.000	0.000	0.000	0.000	
AOH	0.000	0.000	0.000	0.000	0.000	
CAP	129317.106	43105.702	35566.387	249690001.478	15801.582	
Total Cost	129317.106	43105.702	35566.387	249690001.478	15801.582	
Net	-122666.474	-40888.825	-33881.302	225323560.150	15010.781	
Incentives	129317.106	43105.702	35566.387	249690001.478	15801.582	
Net Incentive	-122666.474	-40888.8246666667	-33881.302	225323560.150	15010.7814636829	
Time Period : 2009 Period 01 2009 12/31/2009 12:00:00 AM						
Total Type	Total	Mean	Median	Variance	Std Dev	
Benefit Observations : 2.000						
Benefits	1822.558	911.279	911.279	1660858.832	1288.743	
Amount	6	3.000	3.000	18.000	4.243	
Composition Amount	9	4.500	4.500	40.500	6.364	
Price	1358	679.000	679.000	922082.000	960.251	

The following analysis derives from the Operating Budget dataset. When this analysis was first run it set the Aggregate Using property to Labels and returned 1 observation per Outcome with 6 Outcomes. When the Aggregate Using property was changed to Groups, it aggregated the 6 Outcomes because they belonged to the same Outcome Group in the base elements.



Outcome : 2007 National Park Trail Benefits 01 NPS1001A 12/31/2007

- Benefit Details	
Benefit Observations : 6.00	
Benefit Total : 572,674.03	Benefit Mean : 95,445.67
Benefit Median : 98,613.42	Benefit Var : 252,814,383.92
Benefit Std Dev : 15,900.14	
Incent Total : 572,674.03	Incent Mean : 95,445.67
Incent Median : 98,613.42	Incent Var : 252,814,383.92
Incent Std Dev : 15,900.14	
Amount Total : 20,900.00	Amount Mean : 3,483.333
Amount Median : 2,150.000	Amount Var : 11,861,666.667
Amount Std Dev : 3,444.077	
Comp Amount Total : 31.00	Comp Amount Mean : 5.167
Comp Amount Median : 2.000	Comp Amount Var : 60.167
Comp Amount Std Dev : 7.757	
Price Total : 1,005.00	Price Mean : 167.50
Price Median : 89.50	Price Var : 35,897.70
Price Std Dev : 189.47	

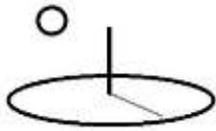
Description :

Operation : 2007 Trailhead Improvement 01 NPS1001A 12/31/2007

- Cost Details	
Cost Observations : 6.00	
OC Total : 89,725.79	OC Mean : 14,954.30
OC Median : 1,034.60	OC Var : 1,190,049,282.45
OC Std Dev : 34,497.09	
AOH Total : 147.07	AOH Mean : 24.51
AOH Median : 21.08	AOH Var : 323.18
AOH Std Dev : 17.98	
CAP Total : 0.00	CAP Mean : 0.00
CAP Median : 0.00	CAP Var : 0.00
CAP Std Dev : 0.00	
Total Cost : 89,872.85	Total Mean : 14,978.81
Total Median : 1,055.68	Total Var : 1,191,210,768.89
Total Std Dev : 34,513.92	
Incent : 89,872.85	Incent Mean : 14,978.81
Incent Median : 1,055.68	Incent Var : 1,191,210,768.89
Incent Std Dev : 34,513.92	
Net : -89,872.85	Net Mean : -14,978.81

3. Change 1 Analyses

The Change 1 Analyses use the Totals calculations to measure incremental changes in aggregated base elements. The NIST 135 reference demonstrates how to use these types of

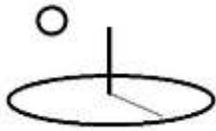


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measurements to make decisions based on benefits and costs. A Change by Year Analysis measures incremental changes between aggregated base elements that have different Years. A Change by Id Analysis measures incremental changes between base elements that have different Ids. A Change by AlternativeType Analysis measures incremental changes between aggregated base 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” element to make comparisons. Gaps in the sequence, such as a missing Year, will be ignored.

Further documentation about these analyses can be found in the Change Analysis 1 reference.

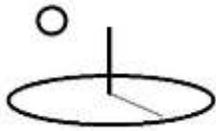
The following image displays a typical result:



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CAP	19337.688	0.000	0.000	14262.290	281.008
Total	21280.140	0.000	0.000	15489.165	267.471
Incent	21280.140	0.000	0.000	15489.165	267.471
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 : 2010-12-31T00:00:00 ; Observations: 3; Alternative : A					
OC	2152.143	211.700	-91.642	1438.412	201.534
AOH	0.168	-1.842	0.000	-1.677	-90.894
CAP	19279.630	-58.058	-0.300	14204.232	279.864
Total	21431.939	151.799	0.713	15640.964	270.092
Incent	21431.939	151.799	0.713	15640.964	270.092
Operation					
2011 Trailhead Improvement 01(Amount: 1.000; Date: 12/31/2011 12:00:00 AM)					
Cost or B Type	Total	Amount Change	Percent Change	Base Change	Base Percent Change
Date : 2011-12-31T00:00:00 ; Observations: 3; Alternative : A					
OC	5399.196	3247.053	64.286	4685.465	656.475
AOH	0.276	0.108	0.000	-1.569	-85.041
CAP	21215.276	1935.646	10.040	16139.878	318.002
Total	26614.750	5182.811	24.183	20823.775	359.590
Incent	26614.750	5182.811	24.183	20823.775	359.590
Feedback About residential/operationgroup/National Park Trailhead Improvement Group/760/none					

The following image displays a typical Comparative Change NPV Analysis.

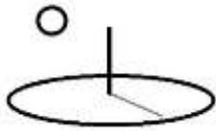


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Investment Group : Public Infrastructure Analysis Example ; 08/21/2013				
Investment	All	Alt. 0	Alt. 1	Alt. 2
Name		Infrastructure Investment 01	Infrastructure Investment 02	Infrastructure Investment 03
Date		12/17/2013	12/17/2013	12/17/2013
Label		NPS1010	NPS1011	NPS1012
Benefits	All	Alt. 0	Alt. 1	Alt. 2
Observations		1	1	1
Alternative		A	B	C
Benefit Total		574,000.00	430,500.00	287,000.00
Benefit AmountChange		0.00	0.00	-143,500.00
Benefit PercentChange		0.00	0.00	-33.33
Benefit BaseChange		0.00	-143,500.00	-287,000.00
Benefit BasePercentChange		0.00	-25.00	-50.00
LCB Total		574,000.00	430,500.00	287,000.00
LCB AmountChange		0.00	0.00	-143,500.00

4. Progress 1 Analysis

A Progress 1 Analysis uses the Totals calculations to measure actual versus planned progress for aggregated base 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

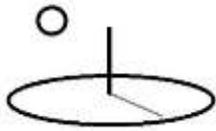


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variances measure the costs (and benefits) of work planned versus actual work completed. Scheduling variances measure the amount, quality, and timeliness of work planned versus actual work completed. EVM uses both variances to measure changes in the 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 and Resource Stock indicators (performance effectiveness).

Further documentation about these analyses can be found in the Earned Value Management Analysis 1 reference.

The following image displays a typical result:



Investment Group : Earned Value Management Example ; 11/07/2013			
Investment	All	Alt. 0	Alt. 1
Name		01 RR Track, Planned	02 RR Track, Actual
Date		08/11/2016	08/11/2016
Label		RR01	RR01
Benefits	All	Alt. 0	Alt. 1
Observations	1		1
Target		benchmark	actual
R Plan Period		4,053,455.07	4,053,455.07
R Plan Full		4,053,455.07	4,053,455.07
R Plan Cumul		4,053,455.07	4,053,455.07
R Actual Period		0.00	1,013,069.13
R Actual Cumul		0.00	1,013,069.13
R Actual Period Change		0.00	-3,040,385.94
R Actual Cumul Change		0.00	-3,040,385.94
R Plan P Percent		0.00	24.99
R Plan C Percent		0.00	24.99
R Plan Full Percent		0.00	24.99
Output Q Plan Period		64.00	64.00
Output Q Plan Full		64.00	64.00
Output Q Plan Cumul		64.00	64.00
Output Q Actual Period		0.00	36.00

5. Other Analyses



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Future releases will include additional types of analyses.

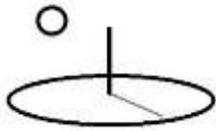
H. Performance Analysis

The Performance Analysis 1 reference demonstrates how to use various Performance Measures, such as Net Savings or Cost per Unit Output, to make decisions involving cost and benefit data. Note that NPV Analysis only uses annual costs and benefits in these Performance Measures. LCA Analysis can use cash flow, life cycle, or unit, costs and benefits. In addition, LCA Analysis includes both aggregated Output and Input Amounts and Prices which support a wide assortment of productivity measurements.

The Social Performance Analysis references demonstrate how to use Performance Measures to value the services generated by public goods. That reference documents techniques that include Monitoring and Evaluation, Performance Monitoring, Impact Evaluation, Life Cycle Analysis, and Cost Effectiveness Analysis. Those references also demonstrate running Life Cycle Input and Output cost and benefit calculations using TEXT datasets and custom algorithms.

I. NPV Analysis, Life Cycle Analysis (LCA), Monitoring and Evaluation Analysis (M&E), and Resource Stock Analysis

These analyzers match the same set of analyzers found in the Life Cycle Analysis, Monitoring and Evaluation Analysis 2, and Resource Stock Analysis references. Section M's Sample Data Sets contain both NPV and LCA Analyzers that demonstrate how the NPV and LCA techniques relate to one another. The LCA totals in these data sets are always somewhat lower than the NPV totals because these particular LCA calculations did not use discounted costs and benefits. In addition, LCA Analysis does not aggregate Inputs or Outputs that have not been calculated using LCC or LCB calculators.



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LCA Analysis is more appropriate to use when costs and benefits need to be defined in greater detail, or with more flexibility, than in NPV Analysis. The Life Cycle references give examples of breaking Inputs into SubCosts, such as Material, Equipment, and Labor and breaking Outputs into SubBenefits, such as Willingness to Pay, Educational Capital, and Concession Stand Sales. Each Input and Output used in an LCA Analysis can be calculated in the same manner as the Operations, Components, and Outcomes used in NPV analysis. The greater detail comes at a cost (at least for now) –the NPV Analyzers can handle larger data sets.

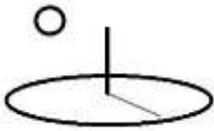
M&E and Resource Stock Analysis are often used together with NPV and LCA Analysis to tie monetary benefits and costs to nonmonetary indicators of performance and outcomes. Cost effectiveness analyses are conducted using both sets of data. See the Social Performance Analysis references for examples.

J. Input and Output Price Analyses

All NPV Analyzers are available for Input and Output Analysis. The Price Analysis 1 reference documents how these analyzers are used to carry out Price Analysis.

K. Multimedia (Resources)

All analysis should be accompanied by multimedia that help to explain the benefit cost analysis. The multimedia can include graphs and other visual aids that help users to interpret all of the data. The economic and resource stock characteristics of the following types of agricultural production, in this case mixed vegetable cropping, are easier to interpret with fuller multimedia support.



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Agricultural Production, Capital Investment Media Pack

Agricultural Production, Capital Investment Benefits and Costs Graph

Capital Investments

Installation costs
Annual benefits
Annual operating and maintenance costs
Time

Agricultural Production, Capital Investment Benefits and Costs Graph description

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Agricultural Production, Capital Investment Discount Rates Influence Nets

High Discount Rates Lead to Less Present Value (PV)

PV
\$100
\$83
\$50
2% 20%
Discount Rate
Present value of \$100 received 1 year from now

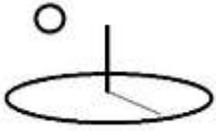
Agricultural Production, Capital Investment Discount Rates Influence Net Returns description

Download Resource Views Select

Agricultural Production, Economic Optimum N Rate

Agricultural Production, Economic Optimum N Rate Graph

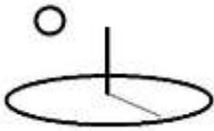
Economic Optimum N Rate and Corn:N Price Ratio



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L. Stories (Linked Views)

All analysis should be accompanied by stories that explain the data, technology, and business practice.



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Case Study (Version 2.1.4): Summary Results, Conservation Tillage, Iowa, United States

This section presents summary data for mean yields, profits, N-in-tile-line, operating costs, and allocated overhead costs. The section also summarizes the analysis of variances used to test the hypotheses that conservation tillage is yield, profit and N-in-tile-line neutral. The data set is explained in the Overview section of this case study (108 budgets 4 tillage treatments 3 crops 3 replications 3 years). These summary results are explained more thoroughly in the Final Results section of this case study. 2.1.4a

The background data and R-project scripts can be downloaded from the 'Statistical Intro' or 'How-to' sections of this case study. The 'How-to' section of this case study also gives instructions for replicating, or improving upon, these results.

Means for Yield, Profits and N-in-tile-line-

The tillage treatments in Figure 1 are: NT No-Till, CP



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M. Knowledge Bank Standards

All NPV 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 production processes, business practices, and technologies. 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 demonstrate 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

Clubs using DevTreks can start to carry out the basic analysis of costs and benefits. Clubs can solicit help when production falters, technology fails, or best practice doesn’t work. They can share structured evidence explaining how to balance benefits with costs. Networks can build knowledge banks that explain why production processes, best or worse business practices, and new or old technologies, succeed or fail and pass that knowledge down to future generations. The result may be farmers who grow better corn, managers who make more profitable widgets, hospitals that treat patients more efficiently, schools that educate children more effectively, workers who work more productively, companies that treat workers more equitably, governments that mitigate climate change more convincingly, and people who improve their lives and livelihoods.

Footnotes

1. Benefit Cost Analysis has a long tradition that includes more advanced analytic techniques than those used in this reference. Future releases are expected to include some of these techniques.

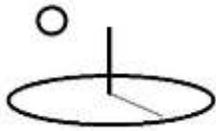


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2. An aggregated Output element uses descriptive properties, such as name and description, from the first Output element being aggregated.
3. Careful review of Output properties will reveal three multipliers can be used with Outputs: Amount, Composition Amount, and Times. We chose not to display the Times property. Instead, the Composition Amount property is a multiplication of Output Times * Output Composition Amount. Due to display considerations, Change and Progress Analyzers do not display Composition Amount totals. Instead, the Total RAmount property is a multiplication of Output Amount * Output Composition Amount (and the latter property is a multiplication of Output Times * Output Composition Amount). The display of this type of data will always present challenges.
4. Change and Progress Analyzers do not include this metric, but the TAMRIncent and TAMIncent properties can be used to derive it, as follows: Incentive Adjusted Net Returns = Benefit Incentive Adjusted Net Returns – Cost Incentive Adjusted Net Returns. Note that LCA Analyzers do not show Incentive Adjusted Benefits or Costs in their results. DevTreks recommends that Incentives be defined in LCA analysis using SubCosts or SubBenefits, rather than base element, properties.
5. The cost and benefit numbers generated by these analyzers were tested within the limitations of existing data sets. While these data sets were built with a broad array of prices, amounts, dates, and multipliers, and compared to the LCA Analyzer results, they were not tested using every combination possible. Initial testing supported our conclusion that the numbers are accurate, but you are encouraged to carry out your own testing. They'll continue to be tested using new combinations of base elements, prices, amounts, dates, amortization periods, and multipliers.

References

U.S. Department of Commerce, National Institute for Standards and Technology. Handbook 135, Life-Cycle Costing Manual. 1996 Edition.



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United States Government Accountability Office. Applied Research and Methods. GAO Cost Estimating and Assessment Guide. Best Practices for Developing and Managing Capital Program Costs. March, 2009.

Hallam, Eidman, Morehart and Klonsky (editors). Commodity Cost and Returns Estimation Handbook, Staff General Research Papers, Iowa State University, Department of Economics, 1999

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/commonstreks/preview/commons/resourcepack/Benefit Cost Analysis 1/506/none/](https://www.devtreks.org/commonstreks/preview/commons/resourcepack/Benefit%20Cost%20Analysis%201/506/none/)