

NORTHROP GRUMMAN



Contractor Costs for Life Cycle Cost Estimating

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Purpose

- Increase the fidelity and defendability of contractor costs associated with future cost estimates
- Develop a process to review and identify trends within contractor costs for use in life-cycle cost estimating
- Identify and analyze the dependent and independent variables associated with contractor costs
- Develop cost estimating relationships (CERs) for use in contractor cost analysis and tool development
- Create a user friendly interface which can be used by stakeholders to utilize the results of the analysis

Problem Statement

- Lack of validated contractor cost benchmarks
 - Complete acquisition plan required in order to reasonably project contractor costs
- Little fidelity in current estimating methodology for contractor costs
- Need to understand the independent variables which effect contractor cost (dependent variable) in order to best project future costs of personnel with limited information

DIA Cost Team Solution

- Collect contractor cost data for analysis
 - Identify data source
 - Normalize collected data
 - Identify independent variables
- Analyze data
 - Identify descriptive statistics
 - Perform regression analysis
- Present Results
 - Significant independent variables and portion of dependant variable explained R^2
 - Cost estimating relationships (CERs)
 - Tool Development

Data Collection

- Five contractor cost samples collected from the top 25 2006 Federal Computer Week Top 140 GSA 70 schedule contractors list
 - Information Technology (IT) Schedule 70 established by GSA to assist federal agencies procure IT products, services, and solutions to meet agency IT missions
 - Selected due to the regulatory and competitive nature of GSA IT Schedule 70s for government procurement
 - Sample companies selected based on total dollar value of contracts and availability of data

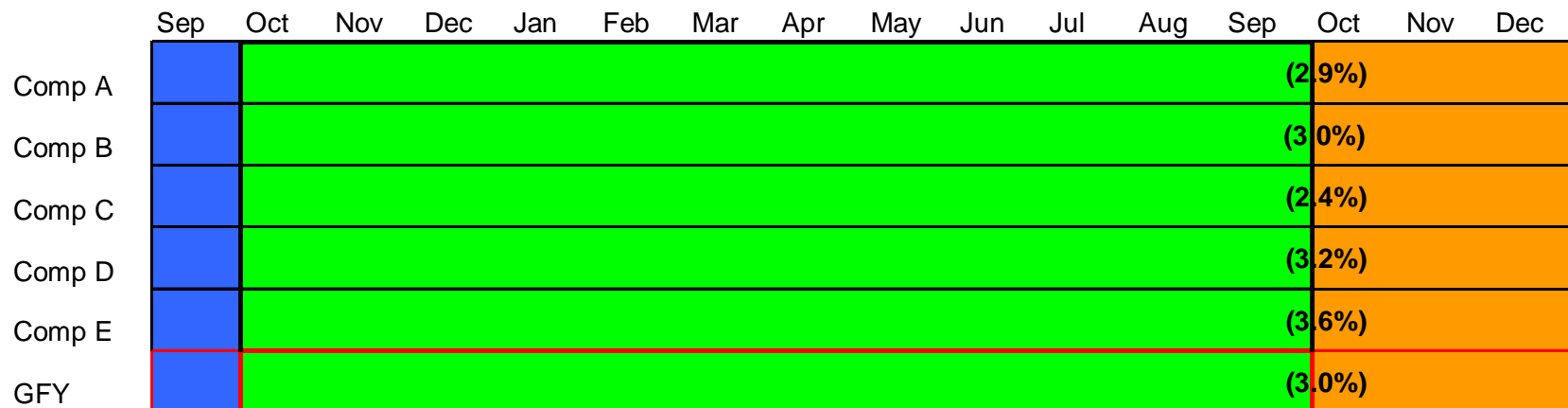
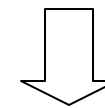
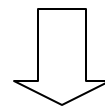
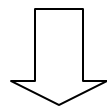
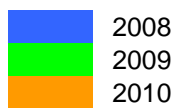
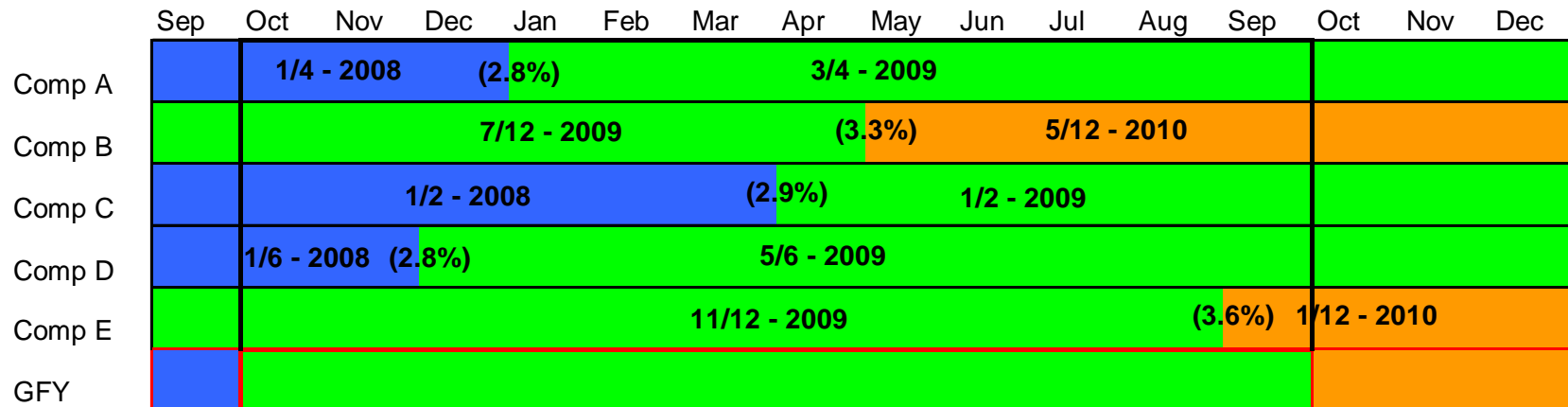
Data Normalization Dependent Variable



- Approach for normalizing the dependent variable (contractor cost) data
 - Sample company's contract fiscal years started and ended on different months (and even different days of the month)
 - Normalization methodology was used to determine the inflation percentage between FYs and convert to GFY
 - $$\text{FY inflation} = \frac{(\text{FY0x+1 total costs}) - (\text{FY0x total costs})}{(\text{FY0x total costs})}$$
 - $$\text{Weighted average} = (\text{Position cost in FY0x} / \text{0x+1 overlap})(1 - (\text{FY0x+1 inflation} * \text{months post FY0x}))$$
 - Standardized labor rates reflect government fiscal year (GFY) rates

Data Normalization

Dependent Variable



Data Normalization

Independent Variables

- Independent variables within the GSA Schedules were captured as both quantitative and qualitative descriptors for individual job classifications with no standard reporting in the GSA schedule
- Needed to identify potential independent variables across companies and develop usable standards
- Quantitative Independent Variables initially identified included:
 - Experience (in years)
- Qualitative Independent Variables initially identified included:
 - Education
 - Job Function (Labor Category)
 - Professional Certification
 - Site or Full rate
- Significant number of additional quantitative and qualitative Independent Variables reviewed during analysis

Data Normalization

Independent Variables – Education Metrics

- Analysis of multiple contractor educational prerequisites revealed metrics
 - Allow employers to substitute educational prerequisites with years of relevant experience
 - Years of experience necessary to substitute for educational prerequisites are consistent across all job categories
- Metric values assigned to educational experience to determine total experience for all positional levels
 - HS Diplomas = 0 yrs
 - AS = 2 yrs
 - BS/BA = 4 yrs
 - MS/MA/MBA = 6 yrs
 - PhD = 10 yrs

Data Normalization

Independent Variables – Benchmark Labor Categories

- Significant analysis of contractor job descriptions revealed six distinct job categories based on specialty and concentration
 - Admin
 - Analyst
 - Management
 - Professional
 - SME
 - Technical
- Statistical analysis later revealed an additional job category (TE) and allowed for the consolidation of two similar positions (Analyst & Technical)
 - Admin
 - Management
 - Professional
 - SME
 - **TE**
 - **Technical**
 - ~~Analyst~~

Data Normalization



Independent Variables – Labor Levels

- Associated positions were assigned levels (jr, mid, sr) based on the years of experience and education

Total E&E Years	Administrative	Technical	Professional	Management	TE	SME
0	1	1				
1						
2						
3						
4	2				1	1
5			1	1		
6						
7	3					
8		2				
9					2	
10						
11						2
12			2	2		
13						
14					3	
15						
16		3				
17			3			
18						
19						
20				3		
21+						3

Data Analysis

Multiple Regression Procedures

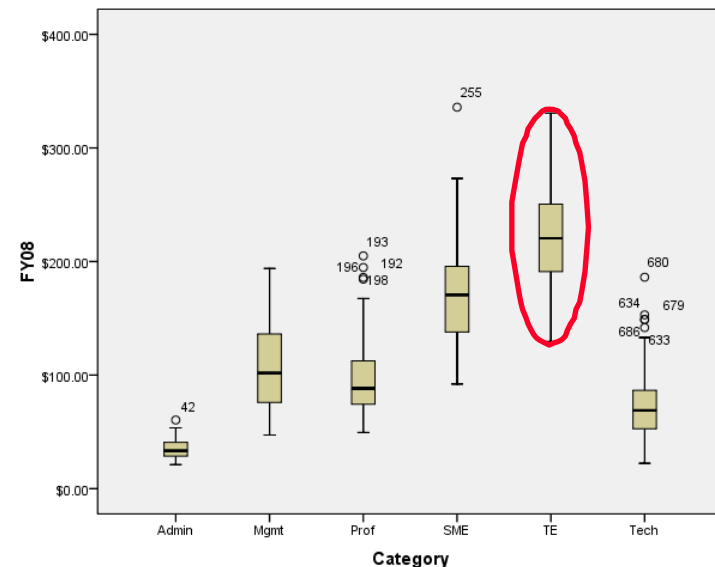
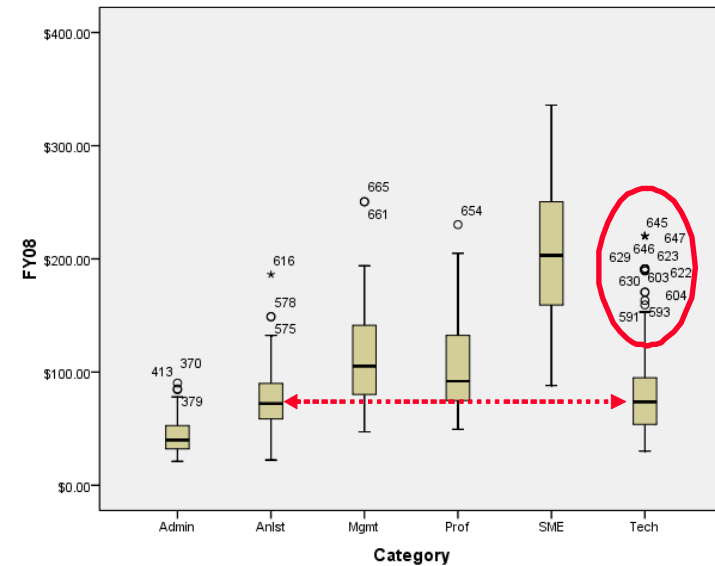
- Regression analysis on individual labor categories
 - Identify and segregate data by labor category
 - Box plot and descriptive statistics
 - Identify correlation between independent variables (multicollinearity)
 - Scatter matrices
 - Review the residual distributions for normality
 - Histograms
 - Run a regression analysis
 - Backward Elimination Technique (BET)

Data Analysis

Box Plot



- Descriptive statistics performed on entire population (segregated by labor category and viewed graphically through a box plot)
- Box plot analysis revealed an additional job category, Technical Expert (TE)
- Statistics also revealed analyst and tech job categories are similar and could be combined
 - Definitions also revealed similarity
 - Categories are now Technical only

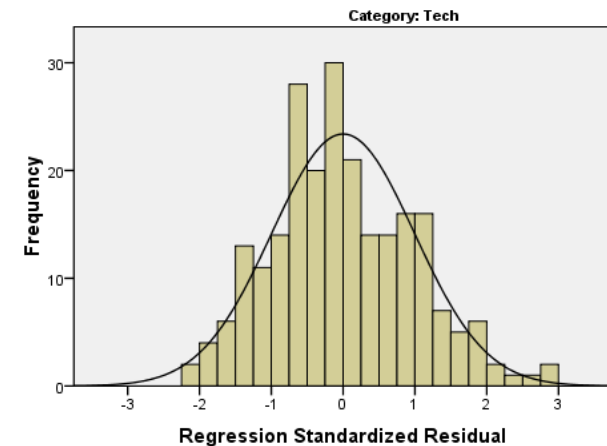
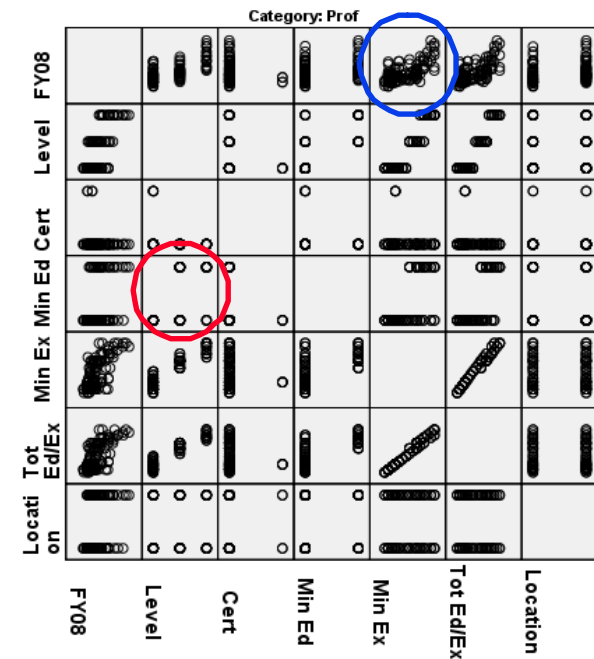


Data Analysis

Scatter Matrix/Histogram



- Identified independent variables and any multicollinearity through use of scatter matrixes
 - Matrix generated for each of the six labor categories
- Significant multicollinearity between several independent variables
 - Level vs education and/or experience
- Population histogram plotted to determine if standardized residuals are normally distributed
 - Indicator of heteroscedasticity
- Histogram reveals signs of slight skewing but not significant to require corrective techniques



Data Analysis

Backward Elimination Technique

- Regression equation computed using all independent variables
- Partial F-test value is calculated for every predictor variable
- Compare lowest partial F-test value to default significant level
 - lowest partial F-test $<$ default value, remove variable and recompute regression with remaining variables
 - all partial F-test values $>$ default value, adopt regression equation as calculated.

Results



R² & Cost Estimating Relationships

- Identified dependent and independent variables which have a significant impact on contractor costs
 - R² of 0.38 for the total population does not allow for high fidelity projections
 - Labor categories developed allow for higher fidelity contractor cost estimating
- Developed CERs for use in the development of contractor cost tools

	R ²
Total Population	0.38
Administration	0.68
Management	0.55
Professional	0.53
SME	0.6
TE	0.72
Technical	0.44

	Total	Admin	Mgmt	Prof	SME	TE	Tech
Certificate	X					X	
Min Ed	X	X				X	X
Min Ex	X	X	X	X	X	X	X
Location	X	X	X	X	X		X

Contractor Cost Model



- Utilizing the data collection, normalization, and analysis described, the Team built an Excel based model with four user in support of the Defense Intelligence Agency (DIA)
 - The first sheet is the Welcome Page which describes the development of the tool, the directions on tool usage, and the analysis sheets available
 - The second sheet is the Directions and Assumptions which details the options available in the analysis sheets, allows the user to best understand decision points in the analysis, and the effects on results
 - The third sheet is the Contractor Cost Estimating (CCE) Tool which allows the user to identify and forecast contractor costs
 - The fourth sheet is the Contractor Cost Verification (CCV) Tool which allows the user to compare current contract rates to those rates from identified through this analysis

Welcome Page



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CONTRACTOR COST MODEL - WELCOME PAGE

Overview

The Contractor Cost Model consists of two tools including the Contractor Cost Estimating (CCE) Tool and the Contractor Cost Verification (CCV) Tool. These two tools provide cost estimators and program managers the ability to estimate and/or verify the costs for contractors, based on a variety of user-defined parameters, in support of the Programming, Planning, Budgeting, and Execution (PPBE) framework. The analysis utilized in the development of the Contractor Cost Model is detailed in the Contractor Cost Model Analysis Paper and is based on data collected from a sample of Government Services Administration (GSA) Schedule 70s (IT Services). All results are based on associated GSA Schedule 70 rates. Analysis details can be provided by the Defense Intelligence Resource Management Office (DIRMO) Program Assessment and Evaluation Division (FE-1D). For questions, please contact Tige Palmer (JWICS: Tige.Palmer@dodis.ic.gov, NIPR: Tige.Palmer@DIA.mil), 703.907.1957.

Directions & Assumptions

The Directions & Assumptions worksheet explains the global and contractor specific assumptions that must be made in order to use this tool. Specific instructions are provided on determining the appropriate assumptions for the Contractor Cost Estimating (CCE) Tool and the Contractor Cost Verification (CCV) tool. In addition, labor category definitions are included for your reference.

Contractor Cost Estimating

The Contractor Cost Estimating (CCE) Tool allows the user to identify and forecast contractor costs based on benchmark rates across government, as reported in GSA Schedule 70. Numerous user-defined assumption categories provide the user flexibility to identify costs for the planning, programming, and budgeting phases of the PPBE.

Contractor Cost Verification

The Contractor Cost Verification (CCV) Tool allows the user to compare contract rates with rates across government. A graphical display and tailored analysis are provided to alert the user of unreasonable values that would require additional investigation. These functions are especially useful during the budgeting and execution phases of the PPBE.



Directions and Assumptions

- Assumption Definitions
 - Allows user to select either “Global” or “Contractor Specific” assumptions and provides definitions and standards
- Labor Category Definitions
 - Provides the Position Definition, General Experience, Functional Responsibilities, and educational and experience prerequisites for the labor category and level defined

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DIRECTIONS & ASSUMPTIONS

Fill Definitions User Input Required Directions

Assumption Definitions	Labor Category Definitions
Please read the directions above before using. First choose the type of assumption (Global or Contractor Specific) and then the individual assumption from the below drop down lists, in order to view definitions and examples.	Please choose the Labor Category along with the level from the below drop down lists. Selecting these parameters will provide the position definition, general experience, functional responsibility, and educational and experience requirements for the chosen Labor Category and Level.
Assumption Type: <i>Global</i>	Labor Category: <i>Prof</i>
Assumption: <i>Inflation Rate</i>	Level: <i>Mid-level</i>
<p>INFLATION RATE The Inflation Rate is the rate at which costs are escalated to reflect yearly percentage increases. The General Defense Intelligence Program (GDIP) Procedural and Administrative Guidance for FY 2010-2015 indicates 2.0% to 2.3% non-pay inflation rate and a 3.0% CIVPAY inflation rate. In addition, the prevalent rate found in the GSA Schedule 70 data was 3.7%. This model will allow you to select an inflation rate based on user requirements, but an inflation rate between 2% AND 4% would be reasonable in most cases.</p>	<p>Position Definition "Individuals requiring the training, skills and experience of Technical Staff, plus extensive breadth and depth of knowledge in one or more specific domains and normally operating in a management structure which provides sophisticated planning, scheduling, performance tracking, risk management and day-to-day program administration. Equivalent experience may be substituted for a degree."</p> <p>General Experience "The Professional Staff is generally experienced in one or more specific domains and may have experience as a subject matter expert in a related military or commercial application. Must possess training or equivalent experience in one of the following types of disciplines: computer science; computer systems; decision support; computer security; electronic commerce; business process reengineering; business process analyses; information architecture planning and design; engineering; operations research; modeling and simulation; math; physics; quality assurance; systems analysis; business or management."</p> <p>Functional Responsibility "The Professional Staff must have been or be able to obtain a security clearance at the level of Secret or higher and/or be able to perform in an environment involving special security requirements, as tasks orders may dictate. Demonstrates a broad knowledge of the technical discipline and applies extensive expertise as a generalist. Applies and/or develops advanced technologies, scientific principles, theories and concepts in related technical disciplines or in a specialty."</p> <p>Specified Education and "Mid-level Professional contractors require a minimum of a Bachelors The Maximum requirements are a experience."</p>

Reduce user error and ensure highest fidelity estimate based on amount of available information

Contractor Cost Estimating (CCE) Tool




- Utilizes CERs developed based on labor categories to estimate contractor costs at a “Detailed” level
 - Requires 5 contractor specific inputs including Experience Level, Education Level, Site vs. Full rate, Labor Category, and Professional Certification requirement.
- Utilizes average costs based on labor categories to identify contractor costs at a “General” level
 - Requires 1 to 3 contractor specific inputs including Labor Category (required), Seniority Level (optional), and Site vs. Full rate (optional)
 - Additional inputs allow the user greater estimate fidelity
- Allows the user to define additional parameters including:
 - Percentile at which to estimate
 - Labor Hours per year
 - Inflation Rate
- Results are provided by contractor type in a FY spread

Results




Contractor Cost Estimating Tool – Detailed Assumptions

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CONTRACTOR COST ESTIMATING TOOL												
Global Assumptions Inflation Rate: 3.00% CNTR Hours / Year: 1750 Percentile: 80% Detailed vs. General: Detailed		Fill Definitions User Input Required Additional User Input Required Output for Contractor Input FYs affected by Inflation Rate			Directions							
	# of CNTRs	FY Start	FY End	Labor Category	Level	Rate†	Experience	Education	Certification			
Input 1	1	2009	2015	Prof		Site	4	Undergraduate	No			
Input 2	1	2009	2015	Prof		Full	7	Masters	No			
Input 3	3	2009	2015	Tech		Site	3	Associates	Yes			
Input 4	5	2009	2015	Tech		Site	5	Undergraduate	No			
Input 5	2	2012	2014	Tech		Site	9	Masters	Yes			
Input 6	2	2012	2015	Prof		Site	7		Yes			
Input 7	4	2013	2014	Admin			3	High School				
Input 8	3	2009	2016	TE		Site		Masters	No			
Input 9	1	2010	2018	SME			10					
Input 10												
Total CNTRs	22.0											
		FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Output 1	-	-	171,932	177,090	182,402	187,875	193,511	199,316	205,296	-	-	-
Output 2	-	-	218,759	218,759	218,759	218,759	225,322	232,082	239,044	-	-	-
Output 3	-	-	292,278	292,278	292,278	292,278	301,046	311,078	319,380	-	-	-
Output 4	-	-	606,263	606,263	606,263	606,263	624,451	643,184	662,480	-	-	-
Output 5	-	-	-	-	-	342,486	352,760	363,343	-	-	-	-
Output 6	-	-	-	-	-	Input Req'd	Input Req'd	Input Req'd	Input Req'd	-	-	-
Output 7	-	-	-	-	-	Input Req'd	Input Req'd	Input Req'd	-	-	-	-
Output 8	-	Input Req'd	Input Req'd	Input Req'd	Input Req'd	Input Req'd	Input Req'd	Input Req'd	Input Req'd	Input Req'd	Input Req'd	Input Req'd
Output 9	-	-	Input Req'd	Input Req'd	Input Req'd	Input Req'd	Input Req'd	Input Req'd	Input Req'd	Input Req'd	Input Req'd	Input Req'd
Output 10	-	-	-	-	-	-	-	-	-	-	-	-
FY Totals			1,289,232	1,294,390	1,299,703	1,647,660	1,697,090	1,748,003	1,426,200	-	-	-
Total CNTRs			10	10	10	12	12	12	10	-	-	-
Average Cost / CNTR			128,923	129,439	129,970	137,305	141,424	145,667	142,620	-	-	-

Results



Contractor Cost Estimating Tool – General Assumptions



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CONTRACTOR COST ESTIMATING TOOL

Global Assumptions	
Inflation Rate	3.00%
CNTR Hours / Year	1750
Percentile	80%
Detailed vs. General	General

Fill Definitions	
User Input Required	
Additional User Input Required	
Output for Contractor Input	
FYs affected by Inflation Rate	

Directions

	# of CNTRs	FY Start	FY End	Labor Category	Level	Rate†	Experience	Education	Certification
Input 1	1	2009	2015	Prof					
Input 2	1	2009	2015	Prof	Mid-level				
Input 3	1	2009	2015	Prof	Mid-level	Site			
Input 4	1	2009	2015	Prof		Site			
Input 5	1	2012	2014	SME	Mid-level	Site			
Input 6	2	2010	2018	Admin	Senior	Site			
Input 7	3	2009	2016	Mgmt		Full			
Input 8	5	2009	2018	Tech		Site			
Input 9	4								
Input 10									
Total CNTRs	19.0								

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Output 1	-	225,400	233,634	242,516	250,782	259,336	267,116	275,129	-	-	-
Output 2	-	212,177	220,346	228,867	237,723	244,854	252,200	259,766	-	-	-
Output 3	-	195,179	202,848	210,816	219,097	225,670	232,440	239,413	-	-	-
Output 4	-	209,908	217,598	225,835	234,498	241,533	248,779	256,242	-	-	-
Output 5	-	-	-	-	354,738	365,381	376,342	-	-	-	-
Output 6	-	-	174,896	181,443	188,228	193,875	199,691	205,682	211,853	218,208	224,754
Output 7	-	805,740	833,308	862,713	893,193	919,989	947,588	976,016	1,005,296	-	-
Output 8	-	754,939	780,361	808,088	836,826	861,931	887,788	914,422	941,855	970,110	999,214
Output 9	-	-	-	-	-	-	-	-	-	-	-
Output 10	-	-	-	-	-	-	-	-	-	-	-
FY Totals	-	2,403,343	2,662,991	2,760,278	3,216,085	3,312,567	3,411,944	3,126,670	2,159,004	1,188,319	1,223,968
Total CNTRs	-	12	14	14	15	15	15	14	10	7	7
Average Cost / CNTR	-	200,279	190,214	197,163	214,406	220,838	227,463	223,334	215,900	169,760	174,853


Contractor Cost Verification Tool

- Utilizes CERs developed for the Contractor Cost Estimating (CCE) Tool at both the “Detailed” and “General” level
- Allows the user to identify parameters including:
 - Base Year
 - Analysis Fiscal Year
 - Current contractor dollar value that you are attempting to verify
 - Current contractor parameters (Experience, Education, etc.)
- Results give the user information that can help determine the reasonableness of the contractor cost identified based on the parameters indicated
- Results include:
 - Then Year dollar value
 - Mean dollar value for a contractor with the identified parameters
 - Identification of a “Reasonable Range” between the 20th and 80th percentiles
 - Percentile at which the contractor cost falls

Results



Contractor Cost Verification Tool (Cont.)



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CONTRACTOR COST VERIFICATION TOOL

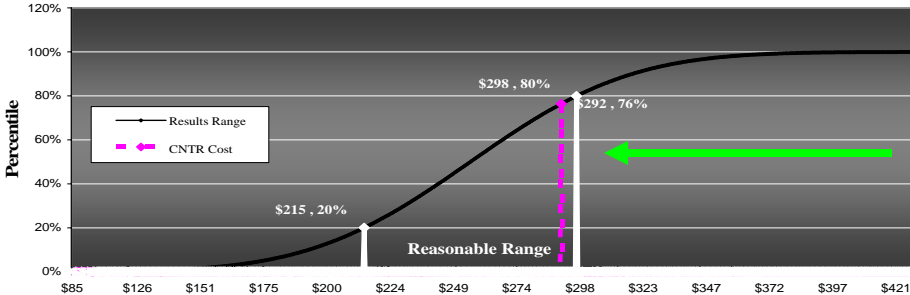
Directions

Global Assumptions	
Inflation Rate*	3.00%
CNTR Hours / Year**	1920
Detailed vs. General	Detailed

Fill
User Input Required
Output

Contractor Specific Assumptions									
Base FY	Analysis FY	Base Year CNTR \$ Value	Labor Category		Rate†	Minimum Experience	Minimum Education	Certification	
2010	2012	\$ 275,000	Prof		Site	12	Undergraduate	No	

Mean and Current Estimates



FY2010 to FY2012 Inflated CNTR \$ Value	FY2012 Mean Cost	Analysis of the CNTR \$ Value Input
\$291,748	\$256,400	<p>The mean value in FY2012 \$\$ for a contractor with the above defined parameters is \$256K. Based on statistical analysis, the input value of \$275K in FY2010 \$\$ (inflated to \$292K in FY2012 \$\$) will be equal to or greater than the actual cost realized approximately 76% of the time. This result is within the range normally considered reasonable.</p>

Statistical Analysis		
Standard Error of the Estimate	# of Standard Deviations	Percentile
\$49,227	0.72	76.42%

Limitations and Future Analysis

- Limitations
 - Only one GSA Schedule analyzed so there is limited usability (based on IT Schedule)
 - Sample based on the GSA Schedule 70 (5 contractor schedules) may exclude certain data and not be indicative of all potential contractors (small businesses)
 - Does not include potential effect of clearance requirements on contractor costs
- Future Analysis
 - Analyze additional GSA Schedules
 - Conduct analysis on clearance requirements and effect on contractor costs
 - Look for additional schedules which include small business concerns

This is a method for analyzing contractor costs which can be used to understand contractor cost drivers and inform further analysis

Presented at the 2009 ISPA/SCEA Joint Annual Conference and Training Workshop - www.iceaaonline.com

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