

DATA ANALYTICS FOR THE PREDICTION OF DBE EXPENDITURES

FINAL REPORT

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS				
SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in ²	square inches	645.2	square millimeters	mm ²
ft ²	square feet	0.093	square meters	m ²
yd ²	square yard	0.836	square meters	m ²
ac	acres	0.405	hectares	ha
mi ²	square miles	2.59	square kilometers	km ²
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft ³	cubic feet	0.028	cubic meters	m ³
yd ³	cubic yards	0.765	cubic meters	m ³
NOTE: volumes greater than 1000 L shall be shown in m ³				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m ²	cd/m ²
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in ²	poundforce per square inch	6.89	kilopascals	kPa
APPROXIMATE CONVERSIONS FROM SI UNITS				
SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm ²	square millimeters	0.0016	square inches	in ²
m ²	square meters	10.764	square feet	ft ²
m ²	square meters	1.195	square yards	yd ²
ha	hectares	2.47	acres	ac
km ²	square kilometers	0.386	square miles	mi ²
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m ³	cubic meters	35.314	cubic feet	ft ³
m ³	cubic meters	1.307	cubic yards	yd ³
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE (exact degrees)				
°C	Celsius	1.8C + 32	Fahrenheit	°F
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m ²	candela/m ²	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in ²

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

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1. Executive Summary:

Disadvantage Business Enterprise (DBE) is a US Department of Transportation (USDOT) program designed to provide small businesses owned by socially and economically disadvantaged individuals the opportunity to effectively compete for transportation contracts. A portion of the federal funds given to Oklahoma DOT (ODOT) in support of major transportation projects is set aside to be contracted or subcontracted only by DBE certified companies. Hence, tracking and, in some cases, forecasting DBE expenditures become important to ensure that the federal funds are expended in accordance with the USDOT requirements.

DBETF is a software developed to allow ODOT Civil Right Division personnel to accomplish four main tools: Accessing expenditure information and rapidly summarizing reports per contractor or subcontractor, Analyzing past and current trends of DBE expenditures per prime vendor and subcontractors, Forecasting DBE expenditures using uniform model or clustering model based on historical DBE spending patterns, and Reporting the state of active contracts as related to allocated DBE targets and their current DBE expenditures.

The following paragraphs briefly describe the developed tools.

[Main Page:](#)

This is the main page of the DBETF application. This page implements several functions to allow computer authentication and data synchronization between the ODOT main database and that placed on the local computer. At no time, the application will write or insert any data into the ODOT database. An application user is asked to enter authentication information prior to performing data synchronization. Once the computer is authenticated, local database is updated with the latest data fetched from ODOT's. First time synchronization may take approximately 30 minutes or more to perform. During synchronization, if the application encounters empty fields of data needed for the calculations, it generates viewable flag message. If a data field is missing, the analysis can still be performed but results will be affected. The Flags could be used by ODOT to confirm that all data fields necessary to perform the needed calculations are inserted and available in the ODOT database. Missing data should be inserted if this case presented itself.

The main page also includes summary information that can be obtained using a contract ID, vendor ID or name, and/or subcontractor ID. Date range and other filters are implemented to narrow the information search. Vendor's (contractor's and subcontractor's) summary information includes current and past awarded contracts, involved subcontractors, total amount of funds awarded, total DBE target funds, among many other parameters.

The main page is also the page that is used to navigate to the Analysis Tools, Forecasting Tools, and Reporting Tools. These are briefly detailed the following section.

[Analysis Page:](#)

This section describes the tools necessary to investigate DBE expenditures as a total or per item in a contract. DBE expenditures are evaluated per multiple parameters: prime vendor, project category or contract type, county, district, or contract ID. Filtering data per date range is

implemented for the page. DBE expenditures are visualized accumulatively or per payment after the study duration is selected.

Three additional tools are implemented, in this section, to rapidly visualize DBE expenditures. These are 1) Stats tool that provides statistical analysis and presentation of the top performers in each category (prime vendor, county, district, among others); 2) DBE Vendor tool that provides vendor information including state and county of origin based on their addresses filed with ODOT; 3) Mapping tool that visualizes DBE expenditures race conscious or neutral on a county level.

Results of the analysis can be exported into images and CSV file format for further analysis and processing. Visualization of the obtained results are presented in charts and pie formats.

[Forecast Page:](#)

This page facilitates forecasting DBE expenditures based on multiple factors: amount of target DBE allotted per contract, contract's Let Date and total Bid days, and vendor's confidence parameter. Confidence parameter is a measure calculated per prime vendor indicating the level of confidence that the vendor will meet its allotted DBE target. The calculation are conducted based on historical data. Several algorithms are implemented to calculate the confidence level.

To forecast DBE expenditures, a user selects period duration with DBETF. The application identifies all active contracts within the duration and their DBE targets. It divides allotted DBE amount per contract uniformly per time period—the amount of DBE expenditure expected to be paid per week. The application sums up DBE amounts for all contracts to present a total target amount per month. This monthly amount is usually constant unless one or multiple new contracts are let or contracts are closed, during the month period being investigate. This total monthly DBE expenditure is the amount expected to be spent by vendors.

The forecasting is based on a vendor's confidence level and the amount allotted to each contract or vendor. If the selected duration includes past month periods, then presented DBE expenditures are the actual amounts. The prediction is only calculated for future periods. Two algorithms are used for forecasting the amounts. One is calculated using uniform distribution of what a vendor is expected to DBE spend based on its confidence level and requested prediction period as percentage of the total bid days. Another is calculated using item-based prediction. It has been found that DBE expenditures historically (2010-2021) have been spent during three periods of a contract. The first period is at the contract Let date; the second period is after several months of Let date; the last period is several months prior to contract's closing date.

[Reporting Page:](#)

This page generates several reports that tracks DBE expenditures and lack of per vendor, county, item, etc. The most important report of these is the one that shows DBE expenditure deficits or shortage. To generate this report, the user provides a DBE threshold above which contracts will be labeled in "deficit" and date range within which contracts will be ending (closing out). The application examines all its current contracts and vendors and generates a list of vendors that are falling behind in DBE payments. The report identifies the deficit amount, the close out date, and contact information that could be used by ODOT to initialize and inquiry with affected vendors.

Reporting results can be exported in CSV and Excel file formats to allow ODOT visualization of data and further post processing capabilities.

1.2 Installation

1. Download and install 'MongoDB Community Server' from <https://www.mongodb.com/try/download/community>.
2. [Usually it is installed automatically for Windows 10] Install '.Net Framework 4.5.2' from <https://www.microsoft.com/en-us/download/details.aspx?id=42642>.
3. Install DBETF using msi setup file.

The following details the algorithms implemented for the development of the DBETF application.

DBE Tracking and Forecast application is intended for ODOT staff to help them analyze, forecast, and report DBE payments and expenditure per contract and vendor. It directly accesses ODOT main database to download contracts' details and store the data into a local database on a computer for further analysis.

2. Main Page

The main screen consists of two panels, as shown in Figure 1 below.

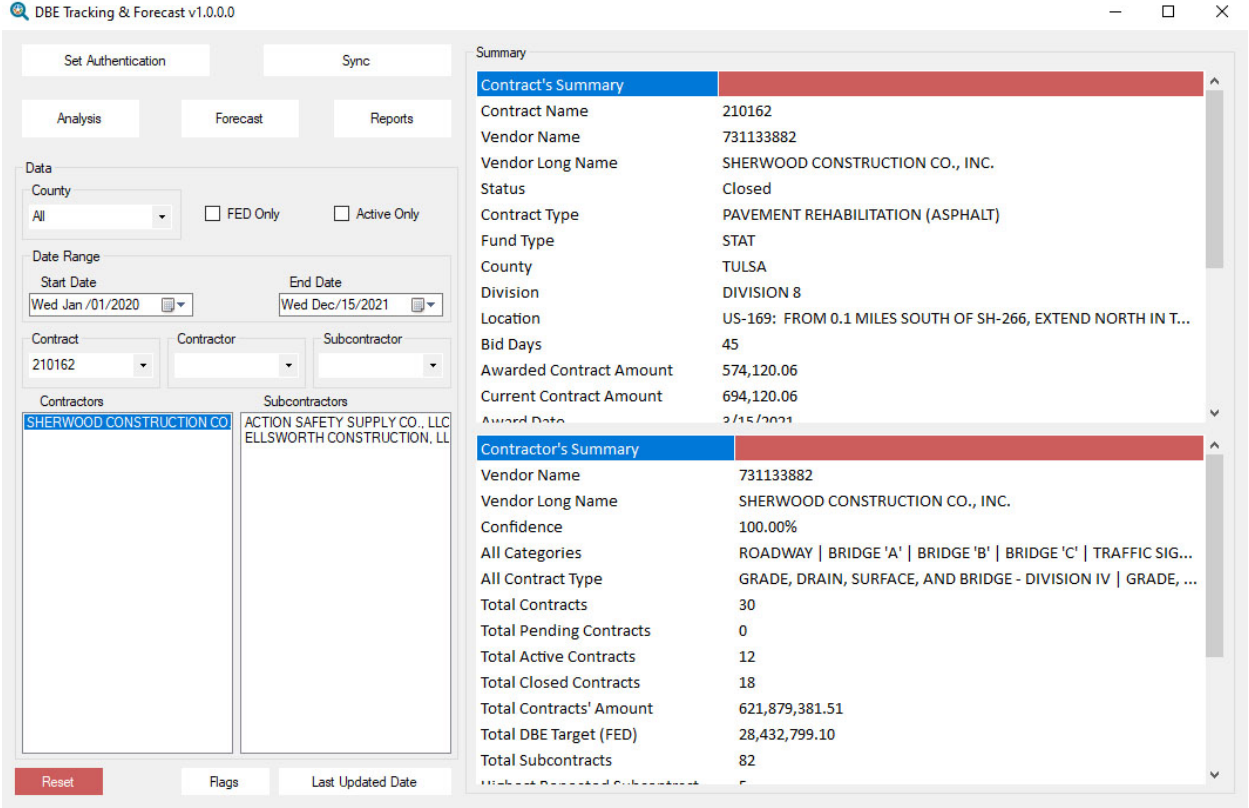


Figure 1. Main Page

The Left panel consists of entry parameters and navigation buttons. The right panel is divided into two windows each is used to display summaries based on the selection made in the left panel.

Software user is allowed to perform a factory Reset to delete the local database of all its content and allow synchronization with the main database. This is used when the local data seems to be corrupt. This data reset will not affect data stored in the ODOT main database.

2.1. Sync

The first action required to operate the application is to fetch contracts' data from the ODOT main database. To do so, one needs to set authentication information only one time using the Set Authentication to enter Username and Password. Once information is provided, a user saves the information. Following authentication, a user can synchronize (Sync) its local data with that on the main database. Notably, first synchronization might take 30 minutes or more, depending on the network speed, data size, and local computing power. Whenever new data is added to the main database,

DBETF user should synchronize and update the local database. This usually happens every two weeks (or whenever payments are made to the vendors.)

2.2. Last Updated Date

The button allows ODOT to review the data that was updated during last synchronization. It presents the update dates for each table.

2.3. Analysis

This option presents a new page/screen that provides a software user with many processing and visualization tools to perform extensive analysis on DBE expenditures. These tools will be detailed under section 3.

2.4. Forecast

This option presents a new page that provides a software user with processing and visualization tools to carry out DBE expenditure forecasting analysis. These tools will be detailed in section 4.

2.5. Reports

This option presents a new page to generate various types of reports in CSV and Excel formats. Generating reports will be detailed in section 5.

2.6. Data Filtering and Selection

Under data selection, application user can input several filtering parameters to determine the outcome of the summary data presented in this page. These parameters are:

- County: User may select a specific county to list its related contracts. Furthermore, user may also select to show contracts with Federal funding support and limit the summary to only active contracts.
 - Federally supported contracts are determined if the *OverallFederalFundingPercent* field obtained from the *Contracts* table is greater than zero.
 - Active contracts are determined if the *ContractStatus* from the *Contracts* table is 'Active' and the *CloseOutDate* is set.
- Date Range: User may filter contracts to select contracts whose *AwardDate* is between *Start Date* and *End Date* duration.

2.7. Data List Menu and Contractor/Subcontractor Summaries

After a software user applies filtering parameters (county, date range, etc.), three Drop Down Lists (situated right under data range) update their contents. The drop down list provides a list of Contracts, Contractors, and Subcontractors. If filtering selection is changed the three lists will update their contents accordingly. The user may select any one item from the three Drop Down Lists to affect the contents of the two display windows (Contractors and Subcontractors) situated below the Lists.

For example, 1) if a contract is selected from the *Contract* drop down list, then involved *Contractors* and *Subcontractors* will be promptly shown on the two display windows; 2) if a contractor is selected from the *Contractor* drop down list, then related *Contracts* and involved *Subcontractors* will be shown in the display windows; 3) if a subcontractor is selected from the *Subcontractor* drop down list, then related *Contracts* and involved *Contractors* will be shown on the two displays.

The summary panel, on the other hand, details extensive information on the contracts, contractors and subcontractors. The following subsections describe the summary information presented under contractor and subcontractor information.

2.7.1. Contract's Summary

Contract summary contains the following data. The field and table from which data was obtained are identified between parentheses.

- Contract Name: provides a unique identification. (*Name* field in the *Contracts* table.)
- Vendor Name: provides an alphanumeric name of the prime vendor that worked on the contract. (*Name* field in the *RefVendors* table.)
- Vendor Long Name: provides a readable name of the prime vendor. (*LongName* field in the *RefVendors* table.)
- Status: provides the state of the contract: 'Active', 'Pending', or 'Closed'. (*ContractStatus* field in the *Contracts* table and *ActualCompletionDate* field when the value of the *Name* field equals to 'KD05' in the *ContractTimes* table.) Status is set 'Active' when the *CloseOutDate* is not defined (missing field).
- Contract Type: provides description of the contract. (*Description* field in the *Contracts* table.)
- Fund Type: contains abbreviation of the agencies that fund the contract. (*TypeofFunding* field in the *Contracts* table.)
- County: provides the county in which a contract is awarded. (*Description* field in the *RefCounties* table.)
- District: provides the district in which a contract is awarded. (The first two characters of the *Name* field in the *RefDistricts* table.)
- Location: provides a location of a contract. (*Location* field in the *Contracts* table.)
- Federal Funding Percentage: provides the federal portion of a contract's funding. (*OverallFederalFundingPercent* field in the *Contracts* table.)
- DBE Goal Percent: provides the portion of the total Federal funds to be spent by a DBE vendors. (*DBEGoalPercent* field in the *Contracts* table.)
- Bid Days: provides the number of days to complete a contract. (*OriginalNumberOfTimeUnits* field in the *ContractTimes* table.)
- Current Bid Days: it is calculated a parameter equals to the sum of the *OriginalNumberOfTimeUnits* and *AdjustedNumberOfTimeUnits* fields in the *ContractTimes* table.
- DBE Target: it is calculated parameter, equals
 - $DBEGoalPercent * AwardedContractAmount$.
- DBE Target (FED): it is calculated parameter, equals a
 - $DBEGoalPercent * OverallFederalFundingPercent * AwardedContractAmount$.
- Award Date: provides a date taken from the *ActualCompletionDate* field when the value of the *Name* field equals to 'AWARD-DT' in the *ContractTimes* table.
- Proceed Date: provides a date taken from the *ActualCompletionDate* field when the value of the *Name* field equals to 'NTP-DT' in the *ContractTimes* table.
- Start Date: provides a date taken from the *ActualCompletionDate* field when the value of the *Name* field equals to 'WKBGN-DT' in the *ContractTimes* table.
- Close Out Date: provides a date taken from the *ActualCompletionDate* field when the value of the *Name* field equals to 'KD05' in the *ContractTimes* table.

- Total DBE Commitment Amount: provides a DBE goal amount. (*TotalCommitAmt* field in the *ContractCurrDbeCommitSummaries* table.)
- Total DBE Race Conscious Commitment Amount: provides a vendor DBE commitment race conscious amount. (*TotalRaceConsciousAmt* field in the *ContractCurrDbeCommitSummaries* table.)
- Total DBE Race Neutral Commitment Amount: provides a vendor DBE commitment for race neutral amount. (*TotalRaceNeutralAmt* in the *ContractCurrDbeCommitSummaries* table.)
- Total Contract Payments: sums up of all payments made on a contract. (*PaidAmount* field in the *ContractPayments* table.)
- Total Item Payments: sums up all items' payments made on a contract. (*ExtendedAmountPaid* field in the *ContractPaymentItems* table.)
- Total DBE Subcontract Payments: sums up all payments that paid to DBE subcontractors of a contract while DBE vendor status is validated. (*PaidAmount* in the *SubcontractorPayments* table and *DbeCertified* field in the *Subcontracts* table, respectively.)
- Total Subcontract Amount: sums of all above payments that paid to all subcontractors of a contract.
- Total Extended Amount: it is taken from *CalcTotalExtendedAmount* field in the *Contracts* table.
- Toward Percent Threshold: it is taken from *CalcTowardsPercentThreshold* field in the *Contracts* table.

2.7.2. Contractor's Summary

It contains the following data:

- Vendor Name: provides an alphanumeric name of the prime vendor that worked on the contract. (*Name* field in the *RefVendors* table.)
- Vendor Long Name: provides a readable name of the prime vendor. (*LongName* field in the *RefVendors* table.)
- Confidence: it is calculated by getting contracts that fulfill the following conditions
 - *CloseOutDate* field is set
 - *DbeGoalPercent* > 0
 - *OverallFederalFundingPercent* > 0
 - *AwardedContractAmount* > 0

It computes a confidence according to the following pseudo code.

```
FOR EACH Contracts
```

```
    Target = AwardedContractAmount * DbeGoalPercent * OverallFederalFundingPercent
```

```
    Diff = Target - DbeSubcontractorPayments
```

```
    IF Diff < 0
```

```
        Diff = 0
```

```
    TotalDiff = TotalDiff + Diff
```

```
    TotalTarget = TotalTarget + Target
```

Confidence = 1 – (TotalDiff / TotalTarget)

where *DbesubcontractorPayments* are calculated by summing *PaidAmount* field in *SubcontractorPayments* when a value of *Dbecertified* field in *Subcontract* equals TRUE.

- All Categories: a union of all categories in contracts that a contractor ever worked on. A category is taken from the *Description* field in the *ContractProjectCategories* table.
- All Contract Types: a union of contract types in contracts that a contractor ever worked on.
- Total Contracts: the number of contracts that a contractor worked on.
- Total Pending Contracts: the number of pending contracts a contractor is expected to start.
- Total Active Contracts: the number of active contracts a contractor is worked on.
- Total Closed Contracts: the number of closed contracts that a contractor worked on.
- Total Contracts' Amount: the sum of the *CurrentContractAmount* field (in *Contracts* table) of all contracts a contractor has ever worked on.
- Total DBE Target (FED): the sum of *DbegoalPercent* * *OverallFederalFundingPercent* * *AwardedContractAmount* of all contracts a contractor has ever worked on.
- Total Subcontracts: the number of subcontracts that a contractor has ever worked with.
- Highest Repeated Subcontractor: lists subcontractors and compute the number of times a contractor has ever worked with. This should equal to the highest number.
- Total Subcontract Amount: the sum of the *CalcTotalSubcontractAmount* field (in *Subcontracts* table) of all subcontractors a contractor has ever worked with.
- Total Subcontract Items Amount: the sum of the *CalcTotalItemsTotal* field (in *Subcontracts* table) of all subcontractors a contractor has ever worked with.
- Total Payments: the sum of all payments of all contracts a contractor has ever worked on. Payment is taken from the *PaidAmount* field in the *ContractPayments* table.
- Total Item Payments: the sum of all item payments of all contracts a contractor has ever worked on. Item payment is taken from the *ExtendedAmountPaid* field in the *ContractPaymentItems* table.
- Total DBE Subcontract Payments: the sum of all DBE subcontractor payments for DBE of all contracts a contractor has ever worked on. (*PaidAmount* in the *SubcontractorPayments* table and *Dbecertified* field in the *Subcontracts* table.)
- Total DBE Item Payments (Approx): the sum of all DBE item payments of all contracts a contractor has ever worked on. DBE item payments is calculated by multiplying each *ExtendedAmountPaid* from the *ContractPaymentItems* table with a *CalculatedDbePercent*. *CalculatedDbePercent* is calculated for each item as the following pseudocode.

```
SubcontractItemsAmount = SUM Amount FOR EACH SubcontractItems
```

```
DbeSubcontractItemsAmount = SUM Amount FOR EACH SubcontractItems IF  
DBECertified = TRUE
```

```
IF SubcontractItemsAmount > ContractItemAmount
```

```
    CalculatedDbePercent = DbeSubcontractItemsAmount / SubcontractItemsAmount
```

```
ELSE
```

```
CalculatedDbePercent = DbeSubcontractItemsAmount / ContractItemAmount
IF CalculatedDbePercent > 1
    CalculatedDbePercent = 1
```

2.7.3. Subcontractor's Summary

It contains the following data:

- Vendor Name: provides an alphanumeric name of the subcontract vendor. (*Name* field in the *RefVendors* table.)
- Vendor Long Name: provides a readable name of the subcontract vendor. (*LongName* field in the *RefVendors* table.)
- DBE Certified: is taken from the *DbeCertified* field in the *Subcontracts* table.
- Supplier Amount: the sum of the *SupplierAmount* field in the *Subcontracts* table of all subcontracts that belong to a vendor.
- Trucker Amount: the sum of the *TruckerAmount* field in the *Subcontracts* table of all subcontracts that belong to a vendor.
- Broker Amount: the sum of the *BrokerAmount* field in the *Subcontracts* table of all subcontracts that belong to a vendor.
- All Contract Types: the union of contract types in contracts that a subcontractor ever worked on.
- Total Contracts: the number of contracts a subcontractor has ever worked on.
- Total Pending Contracts: the number of pending contracts that a subcontractor will be working on.
- Total Active Contracts: the number of active contracts a subcontractor is working on.
- Total Closed Contracts: the number of closed contracts a subcontractor has ever worked on.
- Total Contracts' Amount: the sum of the *CurrentContractAmount* field (in *Contracts* table) of all contracts that a subcontractor worked on.
- Total DBE Target (FED): the sum of *DbeGoalPercent* * *OverallFederalFundingPercent* * *AwardedContractAmount* of all contracts a subcontractor has ever worked on.
- Total Payments: the sum of payments from all contracts a subcontractor has ever worked on. (*PaidAmount* field in the *SubcontractorPayments* table that related to this subcontractor)

2.7.3. Flags:

The *Flags* is used by ODOT to confirm that all data fields necessary to perform the needed calculations are inserted and available in the ODOT database. Missing data should be inserted if this case presented itself. Here is the list of issues that could be flagged.

3. Analysis Page

This page is divided into two display panels. The left panel contains parameters that can be selected before conducting a study. The right panel contains a chart that displays analysis results as illustrated in figure 2. Software user can also export the result to CSV, Excel, or PNG file by pressing on export button at the top right corner.

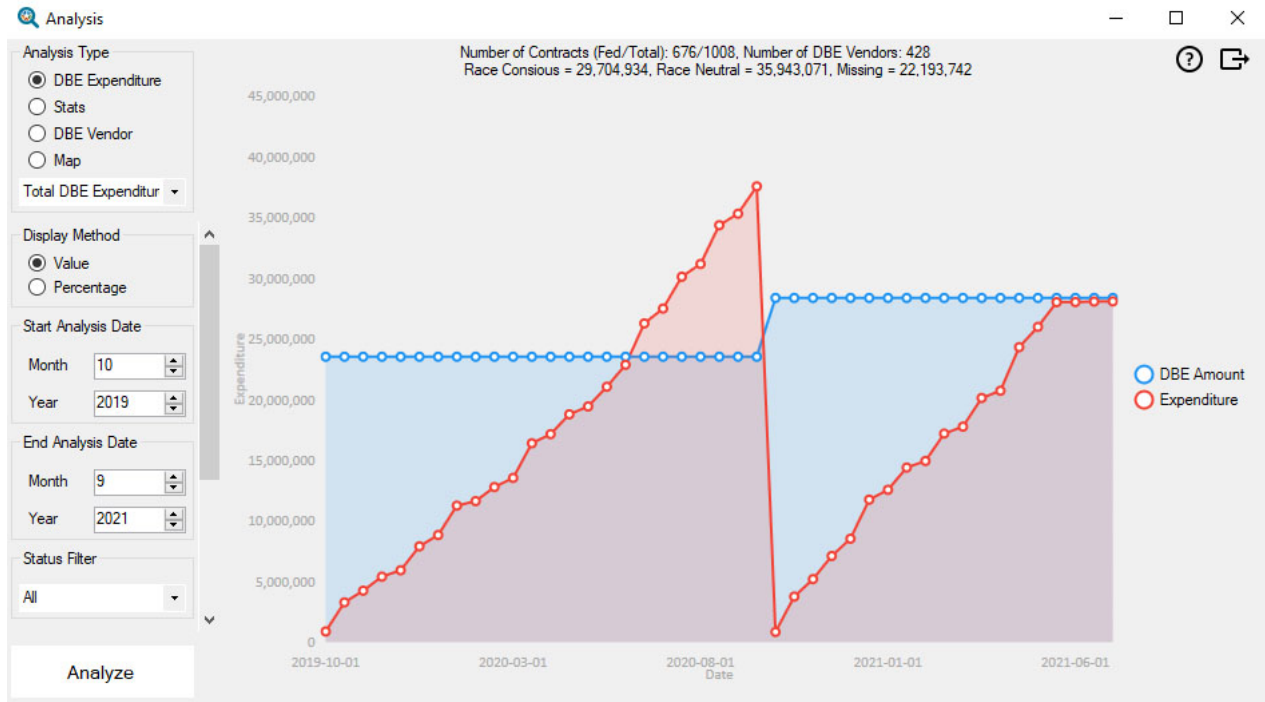


Figure 2. Analysis Page

The left panel displays the options that can be selected by a user. These are as follows:

- **Analysis Type:** shows four different analysis type tools. When one of the four types is chosen, a dropdown list situated below is updated accordingly. Details of each analysis type is described later.
- **Display Method:** DBE payments can be displayed in dollar amount or a percentage level of the total DBE target amount for a particular contract. The calculation method per analysis type is described below.
- **Start Analysis Date / End Analysis Date:** defines the duration of the intended analysis.
- **Status Filter:** selects the data to be used for the analysis. The options are 'All' contracts, 'Active' contracts, or 'Closed' contracts.
- **Sum Method:** DBE payments are combined with options: 'Two Weeks', 'Three Months', 'Six Months', 'One Year', or 'All'.
- **Accumulative:** defines whether to DBE payments are accumulated for the year. Figure 2 shows an accumulative DBE expenditures.
- **Start Month:** defines the first month of the selected year from which data is analyzed and accumulated when enabling 'Accumulative' feature is selected.

3.1. DBE Expenditure Analysis Type

This page provides tools to analyze the type shows DBE expenditures based on various criteria.

3.1.1. Total DBE Expenditure

This analysis calculates the total DBE subcontractors' payments during the selected period.

When Value (in dollar amount) display method is selected, the algorithm works as follows:

Pseudocode 1 Total DBE Expenditure (Value)

- 1 Get federal contracts
- 2 Sum DBE subcontractors' payments of the contracts active during the selected analysis period.
- 3 IF accumulative is checked (selected)
- 4 Accumulate annual payments, starting from the start month
- 5 Compute DBE amount.

When Percentage display method is selected, the algorithm works as follows:

Pseudocode 2 Total DBE Expenditure (Percentage)

- 1 Get federal contracts
- 2 Sum DBE subcontractors' payments of the contracts active during the selected period.
- 3 Get total daily DBE amount of those contracts.
- 4 IF accumulative is checked
- 5 Accumulate annual payments, starting from the start month
- 6 Compute DBE amount
- 7 Divide value payment by the related total DBE amount
- 8 ELSE
- 9 Divide each value of payment by the sum of DBE amount of the selected duration

3.1.2. DBE Expenditure per Prime Vendor

This analysis calculates DBE subcontractors' payments of all contracts belong to a specified prime vendor during a selected duration.

The algorithm works as follows:

Pseudocode 3 DBE Expenditure per Prime Vendor

- 1 Get federal contracts belonging to a selected prime vendor
- 2 Repeat Pseudocode 1 and Pseudocode 2 (step 2 to end) for the selected prime vendor

3.1.3. DBE Item Expenditure per Category

This analysis calculates DBE payments per item per contract per "class" belonging to a specific category during a selected duration.

The algorithm works as follows:

Pseudocode 4 DBE Item Expenditure per Category

- 1 Select category, Get related federal contracts, Get item class related to selected category.
- 2 Sum DBE items' payments for the selected duration, according to the sum method.
- 3 Repeat Pseudocode 1 and Pseudocode 2 (step 3 to end)

3.1.4. DBE Expenditure per Contract Type

This analysis calculates the DBE subcontractors' payments for contracts that have a specific contract type during a specified duration.

The algorithm works as follows:

Pseudocode 5 DBE Expenditure per Contract Type

- 1 Select contract type, Get related federal contracts
- 2 Repeat Pseudocode 1 and Pseudocode 2 (step 2 to end)

3.1.5. DBE Expenditure per County

This analysis calculates the DBE subcontractors' payments for contracts in a specific county during the selected duration.

The algorithm works as follows:

Pseudocode 6 DBE Expenditure per County

- 1 Select a county, Get related federal contracts
- 2 Repeat Pseudocode 1 and Pseudocode 2 (step 2 to end)

3.1.6. DBE Expenditure per District

This analysis calculates the DBE subcontractors' payments for contracts in specific district during a specified duration.

The algorithm works as follows:

Pseudocode 7 DBE Expenditure per District

- 1 Select a district, Get related federal contracts
- 2 Repeat Pseudocode 1 and Pseudocode 2 (step 2 to end)

3.1.7. DBE Expenditure per Contract

This analysis calculates the DBE subcontractors' payments for a specific contract during a specified duration.

The algorithm works as follows:

Pseudocode 8 DBE Expenditure per Contract

- 1 Selected contract
- 2 Repeat Pseudocode 1 and Pseudocode 2 (step 2 to end)

3.1.8. DBE Item Expenditure per Contract

This analysis calculates the DBE items' payments for a specific contract during a specified duration.

The algorithm works as follows:

Pseudocode 9 DBE Item Expenditure per Contract

- 1 Selected contract
- 2 Sum DBE items' payments of the contract between start and end analysis date according to the sum method
- 3 Repeat Pseudocode 1 and Pseudocode 2 (step 2 to end)

3.1.9. DBE Item Expenditure per Contract Item

This analysis calculates the DBE item's payments for a specific item in a contract in a specified duration.

The algorithm works as follows:

Pseudocode 10 DBE Item Expenditure per Contract Item

- 1 Select contract
- 2 Sum DBE contract item's payments according to the sum method
- 3 Repeat Pseudocode 1 and Pseudocode 2 (step 2 to end)

3.2. Stats Analysis Type

This tool type shows the top DBE expenditures based on several selected factors: prime vendor, subcontractor, category, county, district, etc.

3.2.1. Top Prime Vendor Based on DBE Expenditure

This tool calculates the top 8 prime vendors with the highest DBE subcontractors' expenditures during a specified duration. The algorithm is as follows.

Pseudocode 11 Top Prime Vendor Based on DBE Expenditure

- 1 Get federal contracts
- 2 Sum DBE subcontractors' payments of each prime vendor for all related contracts occurred during the selected period.
- 3 Select the highest 8 prime vendor payees.
- 4 Sum the rest of prime vendors' payments under Others.

3.2.2. Top DBE Subcontractor Based on DBE Expenditure

This tool calculates the top 8 DBE subcontractor vendors with the highest DBE subcontractors' payments during a specified duration. The algorithm is as follows:

Pseudocode 12 Top DBE Subcontractor Based on DBE Expenditure

- 1 Get federal contracts
- 2 Sum DBE subcontractors' payments for each subcontractor.
- 3 Select the highest 8 subcontractors' payments
- 4 Sum the rest of prime vendors' payments under Others.

3.2.3. Top Category Based on DBE Expenditure

This tool calculates the top 8 category (item class) with the highest DBE items' payments during a specified duration. The algorithm is as follows:

Pseudocode 13 Top Category Based on DBE Expenditure

- 1 Get federal contracts.
- 2 Sum DBE contract items' payments during a specified period.
- 3 Select the highest 8 item classes' payments.
- 4 Sum the rest of item classes' payments under Others.

3.2.4. Top Contract Type Based on DBE Expenditure

This tool calculates the top 8 contract types with the highest DBE subcontractors' payments during a specified duration. The algorithm is as follows:

Pseudocode 14 Top Contract Type Based on DBE Expenditure

- 1 Get federal contracts
- 2 Sum DBE subcontractors' payments of each contract type from those contracts between start analysis date and end analysis date
- 3 Take highest 8 contract type payments
- 4 Sum the rest of contract type payments under Others

3.2.5. Top County Based on DBE Expenditure

This tool calculates the top 8 counties with the highest DBE subcontractors' payments during a specified duration. The algorithm is as follows:

- 1 Get federal contracts
- 2 Sum DBE subcontractors' payments per county for all contracts during a specified period.
- 3 Select the highest 8 counties' payments
- 4 Sum the rest of counties' payments under Others.

3.2.6. Top District Based on DBE Expenditure

This tool calculates the top 8 districts with the highest DBE subcontractors' payments during a specified duration as follows:

Pseudocode 16 Top District Based on DBE Expenditure

- 1 Get federal contracts
- 2 Sum DBE subcontractors' payments of each district during a specified duration.
- 3 Select the highest 8 districts' payments
- 4 Sum the rest of districts' payments under Others.

3.2.7. Top Contract Based on DBE Expenditure

This tool calculates the top 8 contracts with the highest DBE subcontractors' payments during a specified duration. The algorithm is as follows:

Pseudocode 17 Top Contract Based on DBE Expenditure

- 1 Get federal contracts
- 2 Sum DBE subcontractors' payments for the contract active between start and end analysis date
- 3 Select the highest 8 contracts' payments
- 4 Sum the rest of contracts' payments under Others.

3.2.8. Top Item Based on DBE Expenditure

This tool calculates the top 8 DBE items with the highest payments during a specified duration. The algorithm is as follows.

Pseudocode 18 Top Item Based on DBE Expenditure

- 1 Get federal contracts
- 2 Sum DBE items' payments for the contracts during the selected duration.
- 3 Select the highest 8 contracts' payments
- 4 Sum the rest of contracts' payments under Others.

3.3. DBE Vendor Analysis Type

This page includes tools to operate on DBE certified vendors.

3.3.1. DBE Vendor Distribution per State

This tool counts a number of DBE vendors of each State as follows:

Pseudocode 19 DBE Vendor Distribution per State

- 1 Get DBE vendors from RefVendors table.
- 2 Count vendors that reside with the same state.
- 3 Select the highest 5 States with the highest vendor counts.
- 4 Sum the rest under Others.

3.3.2. DBE Vendors Distribution per Oklahoma County

This tool counts a number of DBE vendors per Oklahoma county. The algorithm is as follows:

Pseudocode 20 DBE Vendors Distribution per Oklahoma Counties

- 1 Get DBE vendors that belong to Oklahoma State from RefVendors table
- 2 Count vendors that reside within the same county.
- 3 Present all counties that have at least two vendors.
- 4 Sum the rest under Others.

3.3.3. DBE Vendors as Prime Vendor

This tool counts the number of DBE vendors that are considered a prime vendor. The algorithm is as follows:

Pseudocode 21 DBE Vendors as Prime Vendor

- 1 Get all prime vendors
- 2 Get all DBE subcontractors
- 3 Compare the two lists.
- 4 Identify DBE subcontractors that were the prime vendors.

3.3.4. DBE Vendor and County

This tool presents DBE payments and contract counts for a specific DBE vendor. It then identifies the payments as paid inside or outside the county in which a DBE vendor resides. The algorithm is as follows:

Pseudocode 22 DBE Vendor and County

- 1 Select certified DBE subcontractor, Get their contracts
- 2 Get DBE subcontractor payments during the selected period
- 3 Sum DBE payments (DBE > 0) and count the contracts (DBE target >0) expended within the same county as subcontractor's residence.
- 4 Sum DBE payments and count the contracts expended outside the subcontractor's county

3.3.5. DBE Vendor and Contract Type

This tool presents DBE payments and contract counts for a specific DBE vendor. It then groups payments according to a contract type. The algorithm is as follows:

Pseudocode 23 DBE Vendor and Contract Type

- 1 Select a DBE certified subcontractor, Get their contracts
- 2 Get the subcontractor's DBE payments paid between the selected start and end analysis date
- 3 Sum DBE payments with (payment >0) and count the contracts (DBE target >0).
- 4 Group DBE payments and counts by contract type

3.3.6. DBE Vendor per Prime Vendor

This tool calculates DBE payments and counts for contracts for a specific prime vendor. The algorithm is as follows:

Pseudocode 24 DBE Vendor per Prime Vendor

- 1 Select prime vendor, Get vendor's contracts during the selected period
- 2 Sum DBE payments and count the contracts per the vendor

3.4. Map Analysis Type

This tool displays DBE payments per county on a map.

3.4.1. DBE Expenditure per County

This tool calculates DBE subcontractors' payments per county in Oklahoma State within the specified duration. The map displays one of the following options: Total Pay Items, Unmet Race Conscious, or Neutral Conscious.

If the Value display method is selected, the algorithm is as follows:

Pseudocode 25 DBE Expenditure per County on Map (Value)

```
1  For each county
2  Get federal contracts per county
3  For each contract
4  Get DBE subcontractors' payments during the selected period.
5  Get DBE target amount for the same period.
6  Compute DBE target annual amount, beginning from the start month
7  IF 'Total Pay Items' is selected
8  Total Pay Items = DBE subcontractors' payments
9  ELSE IF 'Unmet Race Conscious' is selected
10 IF DBE amount > DBE subcontractors' payments
11 Unmet Race Conscious = (DBE target amount - DBE subcontractors' payments)
12 ELSE IF 'Neutral Conscious' is selected
13 IF DBE amount < DBE subcontractors' payments
14 Neutral Conscious = (DBE subcontractors' payments - DBE target amount)
```

If the Percentage display method is selected, the algorithm works as follows:

Pseudocode 26 DBE Expenditure per County on Map (Percentage)

```
1  FOR EACH county
2  Get federal contracts that were for that county
3  FOR EACH contract
4  Get DBE subcontractors' payments during the selected period
5  Get DBE target amount for the same duration
6  Compute DBE amount annually beginning from the start month
7  IF 'Total Pay Items' is selected
8  Total Pay Items = DBE subcontractors' payments / total county DBE target amount
9  ELSE IF 'Unmet Race Conscious' is selected
10 IF DBE amount > DBE subcontractors' payments
11 Unmet Race Conscious = (DBE target amount - DBE subcontractors' payments)
   / total county DBE amount
12 ELSE IF 'Neutral Conscious' is selected
13 IF DBE amount < DBE subcontractors' payments
14 Neutral Conscious = (DBE subcontractors' payments - DBE target amount) /
   total county DBE amount
```

3.4.2. Number of DBE Contracts in County

This tool calculates the number of federal contracts that their award dates are between start and end dates per Oklahoma county.

4. Forecast Page

This page is split into two panels. The left panel contains parameters required to run DBE expenditure prediction. The right panel contains a chart that graphs the prediction results, as illustrated in figure 3. One can also export any result to Excel or PNG image files by clicking on export button at the bottom left corner.

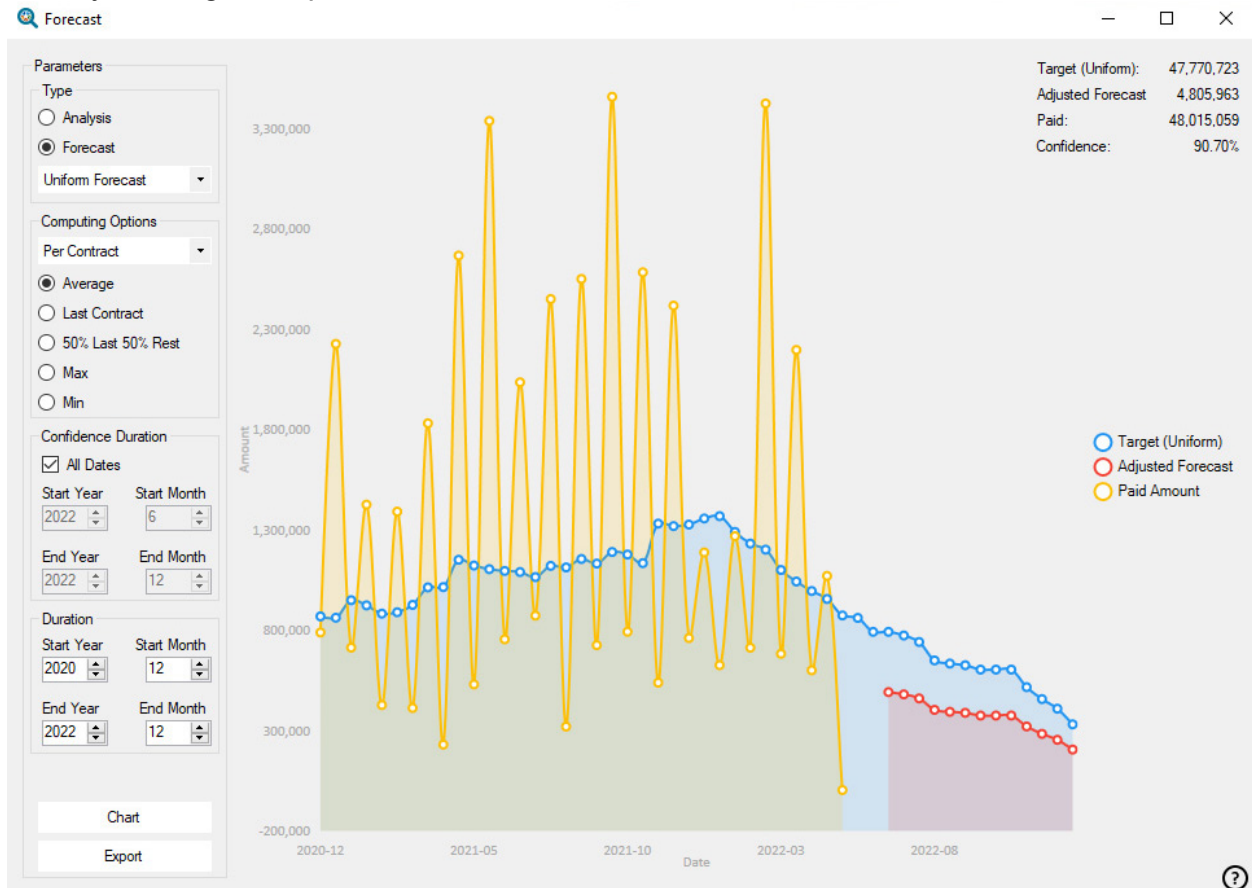


Figure 3. Forecast Page

The left panel consists of the following fields:

- **Type:** two types of tools are available under this page: analysis and forecast. A selection of a type will dictate the Computing Options dropdown list. Details of each type is described later.
- **Computing Options:** determine the method used to compute contractor's confidence level of achieving the DBE target amount per contract. This is calculated based on the contractor historical performance on past contracts.
 - **Average:** the confidence is calculated by averaging achieved DBE targets for all past contracts the contractor was involved in.
 - **Last Contract:** the confidence is the percentage of achieved DBE target of the last contract.

- **50% Last 50% Rest:** the confidence is calculated by summing of weighted achieved DBE targets of past contracts. It sums 50% of achieved DBE target for the last contract and 50% of the achieved targets for the rest of the contracts.
- **Max:** the confidence is the maximum achieved DBE target by the contractor past contracts.
- **Min:** the confidence is the minimum achieved DBE target by the contractor past contracts.
- **Total:** the confidence is calculated as follows:

Sum the difference between DBE target amount and DBE subcontractors' payments per contractor's contract.

Sum the DBE target amount of each contract

Confidence = 1 – (total difference / total DBE target amount)

- **Confidence Duration:** defines start and end dates, the confidence level is calculated per contractor.
- **Start Date / End Date:** defines the forecast duration.

4.1. Analysis Type

This selection calculates the confidence level per contractor and provides analysis to show deviation from actual DBE spending.

4.1.1. Confidence

It calculates a confidence level in percentage of all contractors with active contracts during the selected period. A histogram showing number of contractors distribution over 10 confidence bins.

4.1.2. Deviation

This tool compares the DBE payments and DBE target amount to show deviation between the two values. The target amount of each contract is uniformly distributed each two weeks, starting from the contract's proceed date and ending at its closing date (proceed date + bid days). The total target amount per two weeks is the summing of all contracts. Deviation is then calculated every two weeks between actual DBE payments and anticipated distributed total target amount.

4.2. Forecast Type

Two types of forecast algorithms are offered in DBETF application software.

4.2.1. Uniform Forecast

This type provides anticipated DBE payments based on the total DBE target amount calculated under the forementioned Deviation Section and using the calculated confidence levels for all contractors with active contracts. The type also adjusts its forecast based on the actual DBE expenses paid to the contractors. If the actual DBE payment is below or above the anticipated amount, the algorithm adjusts its anticipated DBE payments accordingly. It adds or removes the blow or above amounts to the anticipated amounts, respectively.

Pseudocode 27 Uniform Forecast

- 1 Get active federal contracts
- 2 Get related DBE payments for those contracts during the selected duration
- 3 Calculate the contracts' total DBE target amount during the same period

- 4 Uniform Distribute total DBE target amount
- 5 Calculate actual total DBE payments
- 6 Uniform Distribute of (DBE target amount – DBE payments) and calculate adjusted forecast starting today till the selected end date.

4.2.2. DBE-Based Forecast

After analyzing historical DBE item payments, it was found that DBE item expenditures can be clustered into mainly three clusters. These major DBE item payments constitute almost 65% of DBE target allocation and are expensed at the beginning, middle, and toward the end of a contract duration. Hence, uniform distribution used in earlier estimation may not render accurate prediction results. Figure 4 shows DBE payment clusters.

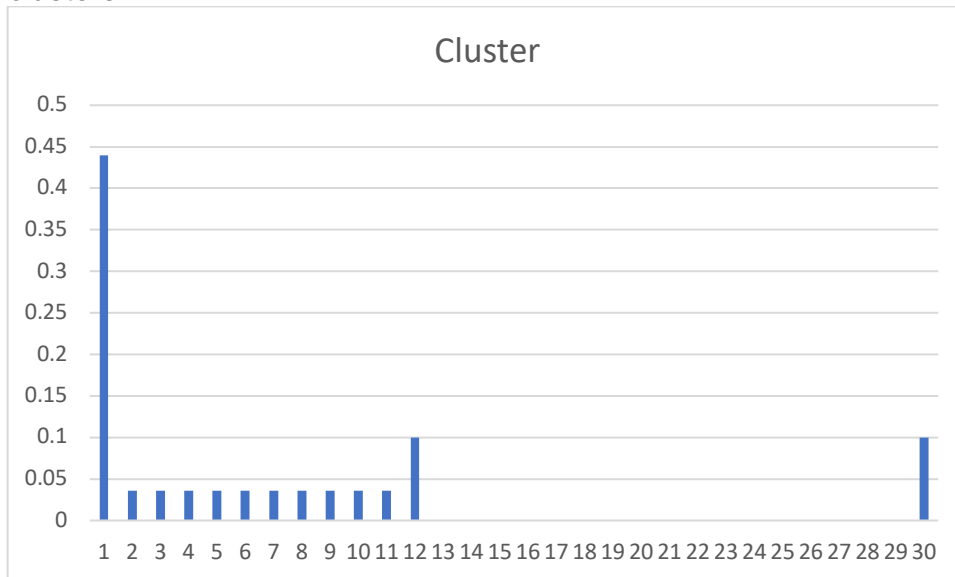


Figure 4. Cluster Item-based Distribution

The forecast algorithm processes DBE (subcontractor) payments, Uniform Target (which is computed by distributing DBE amount based on proceed date and current bid days), and Adjusted Forecast (which is computed for future by adding missing payments to the predefined cluster according to old data statistics). It works as follows:

Pseudocode 28 DBE-Based Forecast

- 1 Get active federal contracts
- 2 Get DBE payments of those contracts for the duration of prediction.
- 3 Get DBE target amount of those contracts for the duration of prediction.
- 4 Uniform Distribute DBE target amount starting of proceed date for the duration of bid days
- 5 Get DBE payments
- 6 Cluster Distribute of (DBE target amount – DBE payments) starting today till end date is Adjusted Forecast

4.2.3. Item-Based Forecast

This forecast algorithm processes DBE (item) payments To allow software operator, to develop accurate item based predictions, the item-based forecast algorithm has been developed. The algorithm is as follows.

Pseudocode 29 Item-Based Forecast

- 1 Get active federal contracts
- 2 Get DBE item payments for the active contracts during the selected period range
- 3 Get DBE target amount for all contracts
- 4 Uniform Distribute DBE target amount for the duration of prediction
- 5 Get DBE item payments
- 6 Cluster Distribute (item unit price * item quantity * item DBE percent) for the duration of prediction.

5. Report Page

This page contains multiple types of reports, the list of which is shown in figure 5. Regardless of the type of reports, one can save the reports into a CSV or Excel file. The most important report is namely DBE Deficit per Contractor report. In this report, one is able to identify all contractors are falling behind DBE payment rate. A detailed description of the report follows.

The screenshot shows a window titled "Reports" with a search icon, a minus sign, a square icon, and a close icon. The window contains two main sections: "Report Type" and "Date Range".

Report Type

- Total DBE Payments
- Total DBE Payments Per Contract
- Total DBE Payments Per Prime Vendor
- Total DBE Payments Per County
- Total DBE Payments Per County Per Item Code
- Total DBE Payments Per Item Code Per County
- DBE Vendors per Prime Vendor
- DBE Deficit per Contractor

Date Range

Start Month	End Month
10	12
Start Year	End Year
2005	2021

Save

Figure 5. Report Generation Page

5.1. Total DBE Payments

This report calculates the sum of DBE payments and per item payments, DBE target amount. The report calculates race conscious and neutral amounts quarterly for the duration of the selected period. The following data is generated.,

- Total DBE payments
- Total DBE Items' payments
- Total DBE Target
- Total Race Conscious
- Total Race Neutral
- Total Missing Race Conscious.

5.2. Total DBE Payments per Contract

This report calculates DBE expenditure data per contract. The generated data is as follows.

- Total DBE payments
- Total DBE Items' payments
- Total DBE Target
- Total Race Conscious
- Total Race Neutral
- Total Missing Race Conscious.

5.3. Total DBE Payments per Prime Vendor

This report generates DBE data per prime vendor as follows.

- Total DBE Subcontractors' payments
- Total DBE Items' payments
- Total DBE Target
- Total Race Conscious
- Total Race Neutral
- Total Missing Race Conscious.

5.4. Total DBE Payments per County

This report generates DBE data per county as follows.

- Total DBE Subcontractors' payments
- Total DBE Items' payments
- Total DBE Target
- Total Race Conscious
- Total Race Neutral
- Total Missing Race Conscious.

5.5. Total DBE Payments per County per Item Code

This report generates the following data:

- Items
- Oklahoma counties for each item
- Total DBE Items' payments for each county per item code for the selected duration.
- DBE/Total DBE percentage:

<i>DBE Items' Payments (of a county)</i>
<i>Total DBE Items' Payments</i>

- DBE/Total percentage:

<i>DBE Items' Payments (of a county)</i>
<i>Total Items' Payments</i>

5.6. Total DBE Payments per Item Code per County

This report generates the following data:

- Oklahoma counties
- Items for each county
- Total DBE Items' payments for each item code per county with the selected duration.
- Item percentage:

<i>DBE Items' Payments (of a county)</i>
<i>Total DBE Items' Payments</i>

5.7. DBE Vendors per Prime Vendor

This report generates the following data.

- Prime vendors
- DBE certified subcontractors that worked with each prime vendor
- Number of contracts that each DBE subcontractor involved per prime vendor
- DBE subcontractor's payments per prime vendor

5.8. DBE Deficit per Contractor

This report requires software operator to input two parameters: number of days to check and deficit threshold.

- Numbers of days. It specifies the number of days left for a contract to close (be done).
- Deficit threshold. It is a percentage of DBE amount below which a contract is considered behind in making DBE payments.

Any contractor is considered in DBE deficit if the either of the following conditions is satisfied:

- If the number of days left to close a contract is less than deficit day numbers AND (DBE target amount – DBE payments) > (DBE target amount * shortage percentage), OR
- If close out date is not set or bid days is not set.

The report lists the following information:

- Contractors that have DBE deficit.
- Contractors' emails
- Contract name that has a deficit
- DBE target amount
- DBE paid amount
- Close out date
- Remaining amount
- Remaining days