

WEB BASED FHI – Functional Specification

Department of local government & Communities

February 2016

WESTERN AUSTRALIAN

TREASURY CORPORATION

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# Introduction

This document outlines the process to assess the financial health of Local Governments (“LGs”) and serves as a methodological guideline for web developers writing the required programming code to calculate and display Financial Health Indicator results (“FHI”) on the web based platform. It is to be used in conjunction with the accompanying Web Based FHI Model (“the Model”) provided to the Department of Local Government and Communities (“DLGC”).

# Data

The seven financial ratios as required by W.A. Local Government regulation are used to analyse and rank the financial health of LG’s.

The seven financial ratios are:

1. The current ratio,
2. The asset consumption ratio,
3. The asset renewal funding ratio,
4. The asset sustainability ratio,
5. The debt service cover ratio (DSCR),
6. The operating surplus ratio, and
7. The own source revenue coverage ratio.

The ratios are recorded for each LG on a financial year basis and are used in the calculation of a corresponding annual FHI result.

# Methodology

The methodology devised for assessing the financial health of LGs consists of two main components:

1. Seven scoring functions that take the given financial ratios in a financial year and convert each one into a numerical score between 0 and 10.
2. Seven ratio importance weights (that sum to one) that are applied to each of the numerical scores so that when the weighted scores are summed, the Financial Health Indicator is produced for that financial year with a value between 0 and 10. A scale factor of 10 is used to provide a final score between 0 and 100.

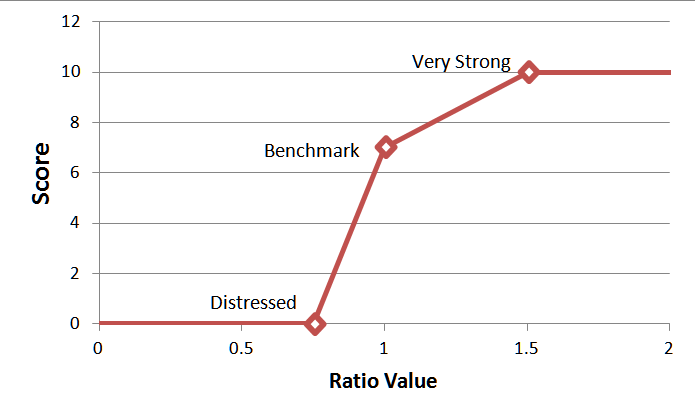
The data analysis process is summarised at a high level in Figure 1:

**Figure 1:** *FHI calculation process flow.*

## Scoring Functions

The scoring functions are piecewise-linear functions that map three ratio values identified as (Low, Benchmark, High) outcomes to the scores . The chosen scoring values are , and an example function for the Current ratio is shown in Figure 1, below. Note that a floor and cap are used to ensure that no local government can be scored worse than zero nor better than 10 for any ratio. The general scoring functions for a ratio value can be expressed mathematically as:

It can be seen from Figure 2 that the scoring function is piecewise-linear, implying that scoring is asymmetric about the benchmark, i.e., ratios below the benchmark are penalised to a greater extent than ratios above the benchmark. The seven scoring functions are in columns N to T of the Model.

**Figure 2:** *Plot of scoring function for the Current Ratio.*

The appropriate function parameters for each ratio have been estimated by DLGC experts and are listed in Table 1 below, and can be found in cells F33 to K40 of the ‘FHI Weightings’ tab in the Model.

**Table 1:** *Parameters for the ratio scoring functions.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Ratio Name | Low Ratio | Benchmark Ratio | High Ratio | Minimum Score | Benchmark Score | Maximum Score |
| Current | 0.75 | 1.00 | 1.50 | 0.00 | 7.00 | 10.00 |
| Asset Consumption | 0.40 | 0.50 | 0.75 | 0.00 | 7.00 | 10.00 |
| Asset Renewal Funding | 0.50 | 0.75 | 1.10 | 0.00 | 7.00 | 10.00 |
| Asset Sustainability | 0.75 | 0.90 | 1.20 | 0.00 | 7.00 | 10.00 |
| Debt Service Cover | 1.00 | 2.00 | 5.00 | 0.00 | 7.00 | 10.00 |
| Operating Surplus | 0.00 | 0.01 | 0.15 | 0.00 | 7.00 | 10.00 |
| Own Source Revenue | 0.30 | 0.40 | 0.90 | 0.00 | 7.00 | 10.00 |

## Ratio Importance Weights

Each ratio score is weighted by combining opinions of various local government experts, so that some

ratios carry more importance (more weight) than others. In aggregating the scores of all seven ratios, we can express the Annual Financial Health Check mathematically as follows. First, we denote a financial ratio of type (where indicates one of the seven ratios) in year as , so that the score for this ratio can be written as . The Annual Financial Health Check (FHI) for year is given by

The weights have been determined by using the *Analytic Hierarchy Process* (AHP), whereby a number of local government experts have completed qualitative questionnaires on the relative importance of each ratio. The survey responses make it possible to determine numerical weights that reflect the importance of each ratio.

The survey has been first conducted at a higher level under four broad categories:

1. Liquidity ratio ;
2. Asset management ratios ;
3. Debt ratio ; and
4. Financial flexibility ratios (,

and then, secondly, within categories for the asset and revenue ratios. The higher-level groupings bring together ratios that are strongly related. So, in effect, we have weightings for the broader categories above, and sub-weightings within the asset and financial flexibility ratio groupings. The category weights are given in Table 2, as well as the individual ratio weights.

**Table 2:** *Ratio importance weights.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Ratio** | **Category Weight** | **Ratio Weight[[1]](#footnote-1)** |
| Liquidity | Current Ratio | 24.3% | 24.3% |
| Asset | Asset Consumption Ratio | 23.1% | 7.9% |
| Asset Renewal Funding Ratio | 6.5% |
| Asset Sustainability Funding Ratio | 8.7% |
| Debt | Debt Service Cover Ratio | 19.3% | 19.3% |
| Financial Flexibility | Operating Surplus Ratio | 33.2% | 21.4% |
| Own Source Revenue Coverage Ratio | 11.8% |

Although the Model calculates the geometric mean of the individual ratio importance surveys, it is envisaged that the summary weightings, as shown in Table 2 above, will be provided by DLGC as an input to the web based platform.

See below for an example calculation.

1. For each ratio value in a given year, determine a standardised score between zero and ten.
2. Multiply each ratio score by its weight in Table 2.
3. Sum the weighted scores to produce the Financial Health Indicator for that year.
4. Multiply by a scale factor of 10 to provide a final projected score between 0 and 100.

**Table 3:** *Example FHI Calculation*



The application of ratio importance weights in the Model is conducted through a user defined FHI function (column V of the ‘Calculations’ tab). The Visual Basic for Applications (“VBA”) code for the FHI function ( is detailed in Appendix 1.

## Missing Ratios

There are instances in which not all seven financial ratios are reported. Since a score cannot be calculated for missing ratios, it is necessary to work around this issue.

If one of the asset or revenue (financial flexibility) ratios is missing, then the other asset or revenue ratio weights, respectively, are rescaled so that they sum to the required overall category weighting. This can be achieved by simply multiplying each the remaining weights in the asset or financial flexibility categories by the required category weight, and dividing by the sum of the remaining weights. For example, if the asset renewal funding ratio is missing (), then we adjust the asset ratio weights to be

and leave all other ratio weights unchanged. The FHI is then calculated using the new weights. A check shows that

as required.

If all the ratios for a particular category are missing, e.g., the current ratio or all three asset ratios are missing, then the weighting for this category needs to be distributed to the other remaining categories/ratios. Again, this is simply achieved by dividing through by the sum of the weights of the remaining observed ratios. For example, if the current ratio is not observed (), then the new weights are:

Recognising that there may be many missing ratios, we can express the Annual Financial Health Check in year in the more general form:

The result is then multiplied by a scale factor of 10 to provide a final projected score between 0 and 100.

# Outputs

## Comparison Selector

The user will be able to select a primary LG and financial year, and a secondary LG and financial year which will form the basis of the radar charts and box plots.

The primary LG and secondary LG may be the same if the user wishes to compare the same LG across different financial years.

## Radar Charts

Once all seven financial ratios have been scored for the LGs, the scores for a single financial year can be plotted in a radar chart as illustrated in Figure 3. These plots allow one to visually assess the strength of LG’s across the seven financial health dimensions.

One can also contrast the blue line representing the primary LG’s scores with the red line representing the secondary LG’sscores to visually assess the differences in financial health.

A Radar chart (spider-web diagram) is a quick way to understand the outcomes from the analysis.

Larger areas of coverage indicate stronger financial health. Smaller areas indicate weaker sustainability.

The closer the radar map is to the centre, the weaker the local government is in that set of ratios.

**Figure 3:** *Example radar chart of the financial ratio scores.*

## Box Plots

To examine the variation in financial health, across LGs in WA within a financial year, it is useful to plot the distribution of Annual Financial Health Checks using a ‘box plot’*.*

A box plot allows one to visually display the set of FHI results for all LG’s in a given financial year. The top-most and bottom-most dashes indicate the maximum and minimum scores, respectively, in the distribution. The first quartile is the value below which 25% of scores fall below. The second quartile, median, is the value below which 50% of scores fall below. Finally, the third quartile is the value below which 75% of scores fall below. This is depicted in Figure 4 below.

**Figure 4** *Box plot depiction.*



The Annual Financial Health Checks for the specific primary and secondary LGs can be positioned on the box plot, allowing one to see where these entities are positioned relative to all other LGs.

Figure 5 illustrates an example of the 2014 FHI trends using the ratio weights. The dotted trend line shows that the financial health of Albany City in 2014 is weaker than Bayswater City in the same year.

**Figure 5:** *Example Annual Financial Health Checks positioned over boxplots.*

The data used to construct the boxplots in the Model are in cells C9 to F18 of the ‘Summary Workings” tab.

# Appendix 1

The user defined FHI function, as per the Model, is detailed below:

Public Function FHI(ratioscoreArray As Range, weightArray As Range) As Double

' Calculates a weighted-average FHI score taking

' into account missing ratios.

' There are 7 ratios with individual weightings, with 4 overall category weightings.

' e.g., there are 3 ratios for the Asset category.

On Error GoTo Err

' array bound checks

If ratioscoreArray.Rows.Count = 1 Then

If ratioscoreArray.Columns.Count <> 7 Then

MsgBox ("function error: FHI - Ratio array bounds incorrect.")

GoTo Err

End If

ElseIf ratioscoreArray.Rows.Count = 7 Then

If ratioscoreArray.Columns.Count <> 1 Then

MsgBox ("function error: FHI - Ratio array bounds incorrect.")

GoTo Err

End If

End If

If weightArray.Rows.Count = 1 Then

If weightArray.Columns.Count <> 7 Then

MsgBox ("function error: FHI - Weight array bounds incorrect.")

GoTo Err

End If

ElseIf weightArray.Rows.Count = 7 Then

If weightArray.Columns.Count <> 1 Then

MsgBox ("function error: FHI - Weight array bounds incorrect.")

GoTo Err

End If

End If

' The ratios are ordered/grouped as follows

' 1. Current

' 2a. Asset Consumption

' 2b. Asset Renewal

' 2c. Asset Sustainability

' 3. DSCR

' 4a. Operating Surplus

' 4b. Own Source Revenue Coverage

' If we have a missing ratio, then we first want to normalise the weights within the same category.

' If there are are no other weights in this category, then all weights are to be renormalised.

Dim i As Long

' Arrays to store the final weights & ratio scores

Dim w(1 To 7) As Double

Dim r(1 To 7) As Double

' CURRENT RATIO

If IsNumeric(ratioscoreArray(1)) And Len(ratioscoreArray(1)) > 0 Then

w(1) = weightArray(1)

r(1) = ratioscoreArray(1)

Else

' no value for this ratio - need to ignore the weighting for this ratio when summing weights for normalisation

w(1) = 0#

r(1) = 1#

End If

' ASSET RATIOS

Dim dRequiredTotalAssetWeighting As Double, dAssetWeighting As Double

dRequiredTotalAssetWeighting = 0#

dAssetWeighting = 0#

Dim bHaveNoAssetRatios As Boolean

bHaveNoAssetRatios = True

For i = 2 To 4

If IsNumeric(ratioscoreArray(i)) And Len(ratioscoreArray(i)) > 0 Then

w(i) = weightArray(i)

r(i) = ratioscoreArray(i)

dAssetWeighting = dAssetWeighting + w(i)

bHaveNoAssetRatios = False

Else

' no value for this ratio - need to ignore the weighting for this ratio when summing weights for normalisation

w(i) = 0#

r(i) = 0#

End If

dRequiredTotalAssetWeighting = dRequiredTotalAssetWeighting + weightArray(i)

Next i

' normalise the asset weights

If bHaveNoAssetRatios Then

' no need to adjust asset weight to satisfy overall asset category weight

Else

For i = 2 To 4

w(i) = w(i) \* dRequiredTotalAssetWeighting / dAssetWeighting

Next i

End If

' DEBT RATIO

If IsNumeric(ratioscoreArray(5)) And Len(ratioscoreArray(5)) > 0 Then

w(5) = weightArray(5)

r(5) = ratioscoreArray(5)

Else

' no value for this ratio - need to ignore the weighting for this ratio when summing weights for normalisation

w(5) = 0#

r(5) = 1#

End If

' REVENUE RATIOS

Dim dRequiredTotalARevenueWeighting As Double, dRevenueWeightingSum As Double

dRequiredTotalARevenueWeighting = 0#

dRevenueWeightingSum = 0#

Dim bHaveNoRevenueRatios As Boolean

bHaveNoRevenueRatios = True

For i = 6 To 7

If IsNumeric(ratioscoreArray(i)) And Len(ratioscoreArray(i)) > 0 Then

w(i) = weightArray(i)

r(i) = ratioscoreArray(i)

dRevenueWeightingSum = dRevenueWeightingSum + w(i)

bHaveNoRevenueRatios = False

Else

' no value for this ratio - need to ignore the weighting for this ratio when summing weights for normalisation

w(i) = 0#

r(i) = 0#

End If

dRequiredTotalARevenueWeighting = dRequiredTotalARevenueWeighting + weightArray(i)

Next i

' normalise the revenue weights

If bHaveNoRevenueRatios Then

' no need to adjust asset weight to satisfy overall revenue category weight

Else

For i = 6 To 7

w(i) = w(i) \* dRequiredTotalARevenueWeighting / dRevenueWeightingSum

Next i

End If

Dim dNewSumWeights As Double

dNewSumWeights = 0#

For i = 1 To 7

dNewSumWeights = dNewSumWeights + w(i)

Next i

' Now calculate the FSR sum

Dim dScore As Double

dScore = 0#

For i = 1 To 7

dScore = dScore + r(i) \* w(i) / dNewSumWeights

Next i

AHFC = 10 \* dScore ' rescaled to give final FSR from [0:100]

Exit Function ' successful function call

Err: ' catches errors

FHI = -1

End Function

1. Note: Figures do not sum to 100% due to rounding. [↑](#footnote-ref-1)