LCCA Module in Athena Pavement LCA

Life cycle cost analysis (LCCA) is an analytical framework frequently used by decision-makers to compare the total cost to construct, maintain, and operate alternative pavement design and maintenance strategies. LCCA modeling is an optional feature in the Pavement LCA application.

A deterministic economic assessment model is used to quantify agency costs associated with pavement production and their maintenance and rehabilitation (M&R), as well as user costs due to excess fuel consumption from pavement-vehicle interaction (PVI). This model was provided by Mehdi Akbarian from the Concrete Sustainability Hub at MIT.

Cost Items

Cost data characterization is of significant importance to LCCAs. We focused on ensuring that Cost Item Data can be flexibly managed and is optimally reusable.

- A **Cost Item Reference Library** has been created for Ontario and Quebec roadways using data from Applied Research Associates (ARA): "Methodology for the Development of Equivalent Pavement Structural Design Matrix for Municipal Roadways" (two reports, one for Ontario and another for Montreal and Quebec City). Additionally, starter collections are provided for Material Types for extra material costing, Activity Types as a quick pick for M&R activity costing, and Fuels used for Operating Energy Consumption and PVI. These library cost items can not be directly edited but can be copied to a User Cost Item Library or as Project Cost Items and the copies can be edited.
- A **User Cost Item Library** can be created by each user. Cost Items can be copied from the Cost Item Reference Library, or manually created and uniquely specified. Users can fully edit these records.
- **Project Cost Items**: Each project has a Cost Items tab where Cost Items can be manually created and uniquely specified, or copied from either the User or Reference Libraries. Only Cost Items that are present in the Project Cost Items tab can be inherited and applied to Initial Construction, M&R Activities, or automatically applied to costing for Extra Materials, Operating Energy Consumption, and Excess Fuel Consumption due to PVI.
- **Project LCCA Inputs**: Project Currency, USD to CAD Exchange Rate, Real Inflation Rate, and Real Discount Rate inputs have been added to the Project Information tab. These values will be used by default when generating LCCA reports for the project. When generating LCCA comparison reports, values from the first project selected will be used.
    - **USD to CAD Exchange Rate**: Only USD and CAD currencies are supported. To find the most recent exchange rate, click the question mark to launch Bank of Canada Daily Exchange Rate webpage.
    - **Real Inflation Rate**: The real inflation rate corresponds to the latest annual inflation rate for the selected Project Location as determined by the World Bank. Click the question mark to launch the World Bank real inflation rate webpage. Download the Excel file to see the latest annual inflation rate.

- **Real Discount Rate**: The real discount rate corresponds to a 10-year running average of interest rates for the selected Project Location as determined by the World Bank. Click the question mark to launch the World Bank real interest rate webpage. Download the Excel file then calculate the 10-year average.

Cost Item Mandatory inputs:

- **Cost Item Type**: Site Prep, Construction, Maintenance, Operation, End of Life. At present, Site Prep and End of Life are not calculated. They are placeholders for possible future inclusion in the LCCA module. Note that the Energy drop-down list is only available when Operation is selected as the Cost Item Type.
- **Activity Type**: all the M&R Activity Types plus Operation and Initial Construction. If Cost Item Type is Operation, the Activity Type must be Operation.
- **Currency**: CAD, USD
- **Unit Cost**: The default unit cost for the specified cost item. If EOS is enabled, the unit cost value will be calculated later.
- **Units**: SI, Imperial
- **Unit of Measure** (UOM)

Cost Item Optional inputs:

- **Activity**: all the Construction and M&R Activities plus Operation and Initial Construction.
- **Material Type**: all supported Material Type records. When a Material Type is selected, the Material drop down list is enabled and populated with a filtered list of material records that are linked to the selected Material Type. Selecting a Material Type record permits costing to be calculated for all linked materials that are used in Extra materials.
- **Material**: all supported Material records that are linked to the selected Material Type. Selecting a material record permits material specific costing to be applied for calculating costs associated with Extra Materials and possible future ability to calculate the initial roadway construction based on the materials used in the Roadway Design plus site prep.
- **Energy**: all supported Energy and Fuel records. The Energy drop down list is only available when Operation is selected as the Cost Item Type. Cost Item data entered here can be automatically used when calculating costs associated with Operating Energy Consumption and Excess Fuel Consumption due to PVI.
- **Price Distribution Form**: The default is Log-normal and is included for possible future inclusion of probabilistic calculations.
- **Economy of Scale**: used for calculating a quantity dependent Unit Cost based on a straight line relationship as defined by the following EOS inputs:
    - **EOS Intercept** (the vertical axis value where the line crosses the vertical axis)
    - **EOS Slope** (the slope of the straight line)
    - **EOS Standard Error** (the standard error for the data. This is a placeholder for possible future inclusion of probabilistic calculations)
- **Cost Standard Deviation Rate**: The default is 10% and is a placeholder for possible future inclusion of probabilistic calculations.

LCCA Reports

Life Cycle Cost Analysis reports are provided in project-specific and multi-project comparison report formats.

Project-specific LCCA Reports:

Click on the Reports menu item, then click Project Reports to launch the Project Reports configuration form. Pick a project, then click on the "$ Life Cycle Cost Analysis" tab and accept or change the LCCA inputs (Report Currency, USD to CAD Exchange Rate, Real Inflation Rate, Real Discount Rate). These input values will be inherited from the selected project. Next, click the "Submit Report Request" to get just the LCCA reports, or click the "Submit All Reports Request" button to get all selected Summary Measure, Absolute Value, BOM, and LCCA reports presented in a single multi-tab page.

At present (March 2018), the Export to Excel only exports the table data, not the charts.

Multi-Project LCCA Comparison Reports:

Click on the Reports menu item, then click Comparison Reports to launch the Multiple Project Comparison Reports configuration form. Select two or more projects. Click the "Life Cycle Cost Comparison Report Configuration" tab, and accept or change the LCCA inputs (Report Currency, USD to CAD Exchange Rate, Real Inflation Rate, Real Discount Rate). These input values will be inherited from the first selected project. Next, click the "Submit Report Request" to get just the LCCA reports.

At present (March 2018),, the Export to Excel only exports the table data, not the charts.