



Project Summary Report O-4726-S

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Project O-4726: Development of a Toll Viability Screening Tool

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## Summary Report: Development of a Toll Viability Screening Tool

The original project statement set the following challenge:

“This research project will develop a set of Excel spreadsheet forecasting models that provide: 1) an assessment of the potential variability associated with the point travel demand estimates, and 2) a complete and thorough sensitivity analysis of all input parameters that impact on the associated point estimates and upon the decisions relating to critical issues such as predicted debt coverage ratios of estimated net revenues to debt service. The results produced by the model will allow TxDOT and local officials to know enough about the potential viability of toll revenues as a funding source to decide whether to pursue the more detailed toll feasibility study.”

Initial investigations revealed that the need for improved estimating techniques went beyond the variability of demand estimates, so the challenge can be redefined by the following:

- The Texas Department of Transportation (TxDOT) is increasingly considering tolling as an important funding source, potentially on all projects.
- The number of projects under consideration demands a user-friendly, district-level tool to assist in developing meaningful revenue estimates.
- Robust revenue projections are essential for developing financial plans.
- Revenue projections include many variables—such as annual traffic volumes, toll road traffic share, and initial toll rates—for which assumptions must be made.
- The typical use of point estimates for assumed values ignores the inherent variability and increases the uncertainty of the revenue estimate.
- Manually changing the assumptions in a spreadsheet one by one to better reflect variability is time consuming and may not improve the quality of the revenue estimate.
- Without understanding which assumptions have maximum impact on revenue, TxDOT cannot know the level of uncertainty in the revenue estimate, nor where to apply resources or analytical skills to improve the quality of the assumptions.
- There is limited experience among public agencies and in the published literature regarding techniques for estimating these variables, especially in a toll road context.

### What We Did...

The basic approach to the project is outlined in the items below.

- *Develop a comprehensive, flexible static spreadsheet model to calculate revenues with user-supplied inputs (assumptions).* Figure 1 illustrates the structure of the model. Equation 1 was the basis for the static spreadsheet model.

#### Equation 1

$$\text{Revenue (year } i) = \text{ADT (year } i) * [(\% \text{ cars} * \% \text{ toll road share-cars} * \text{toll rate-cars}) + (\% \text{ trucks} * \% \text{ toll road share-trucks} * \text{toll rate-trucks})] * \text{toll road length} * \text{annual revenue days}$$

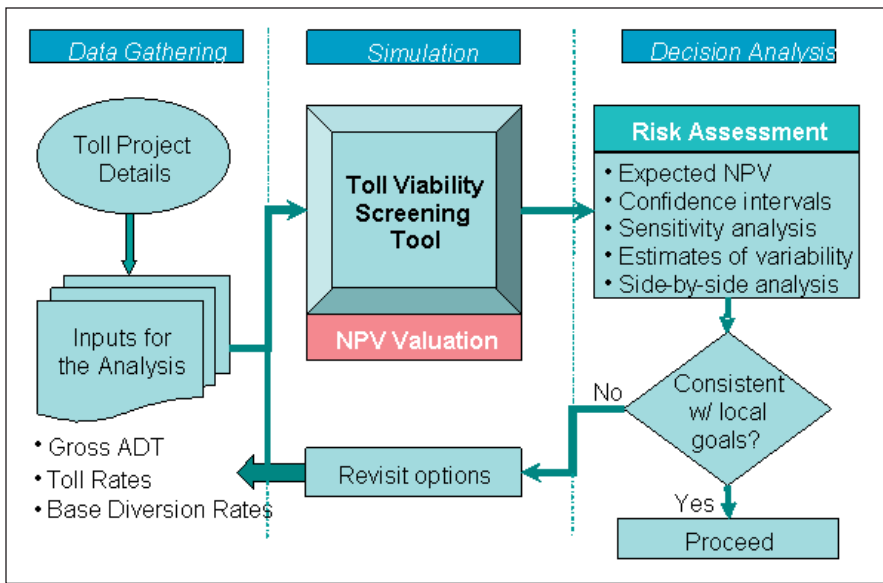



Figure 1. Schematic Depiction of the Toll Viability Process.

- *Identify a user-friendly statistical distribution that would roughly approximate the probability distribution for the variables in the model.* In Equation 1, all of the variables in italics are unknowns that must be assumed. To reduce the risk associated with point estimates for assumptions, we identified appropriate, user-friendly distributions to substitute for the point estimates. We employed a triangular distribution (Figure 2) to represent the range of variability in most of the variables. The triangular

distribution is not as familiar as the normal distribution (bell curve), but it is easy to use and is a reasonable approximation.

- *Incorporate the static spreadsheet model and the selected statistical distributions into a user-friendly simulation model.* To facilitate calculation of revenue estimates that now contain distributions of variables instead of point estimates of variables, we introduced a simple, user-friendly, Excel®-based simulation model to perform the calculations. Using an off-the-shelf program,

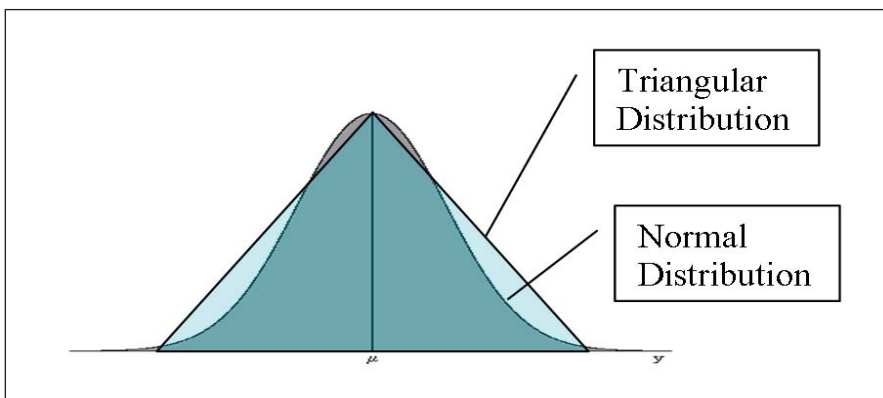


Figure 2. Similarity of Normal Distribution and Triangular Distribution Used in the Model.

@Risk® (from DecisionTools Suite 4.5), we developed a customized spreadsheet model that incorporates all relevant user inputs, as well as the triangular distributions for appropriate variables.

- *Produce graphic outputs that aid the analyst in assessing the confidence of the revenue estimate and the sensitivity of the estimate to the input variables.* To highlight which variables have maximum impact on the revenue estimate, we included an automated sensitivity analysis. A sensitivity analysis holds all variables constant and then looks at the impact of changing the value of just one of the variables. By sequencing through all variables in the model using that approach, the result is the list of influential variables ranked from maximum influence to negligible influence.

### What We Found...

The simulation model in @Risk produces several useful outputs:

- Toll road average daily traffic (ADT) is provided for each year of the project. This output reflects the assumptions made about the share of corridor ADT that will use the toll road versus the best non-toll alternative. If this assumed share is found to be a significant assumption in the sensitivity analysis, then the analyst may want to verify the basis for the assumption.
- Annual revenue, by vehicle category, is provided in tabular and graphic form. The value shown is the expected value for each year. More detailed data are provided in the internal @Risk output.



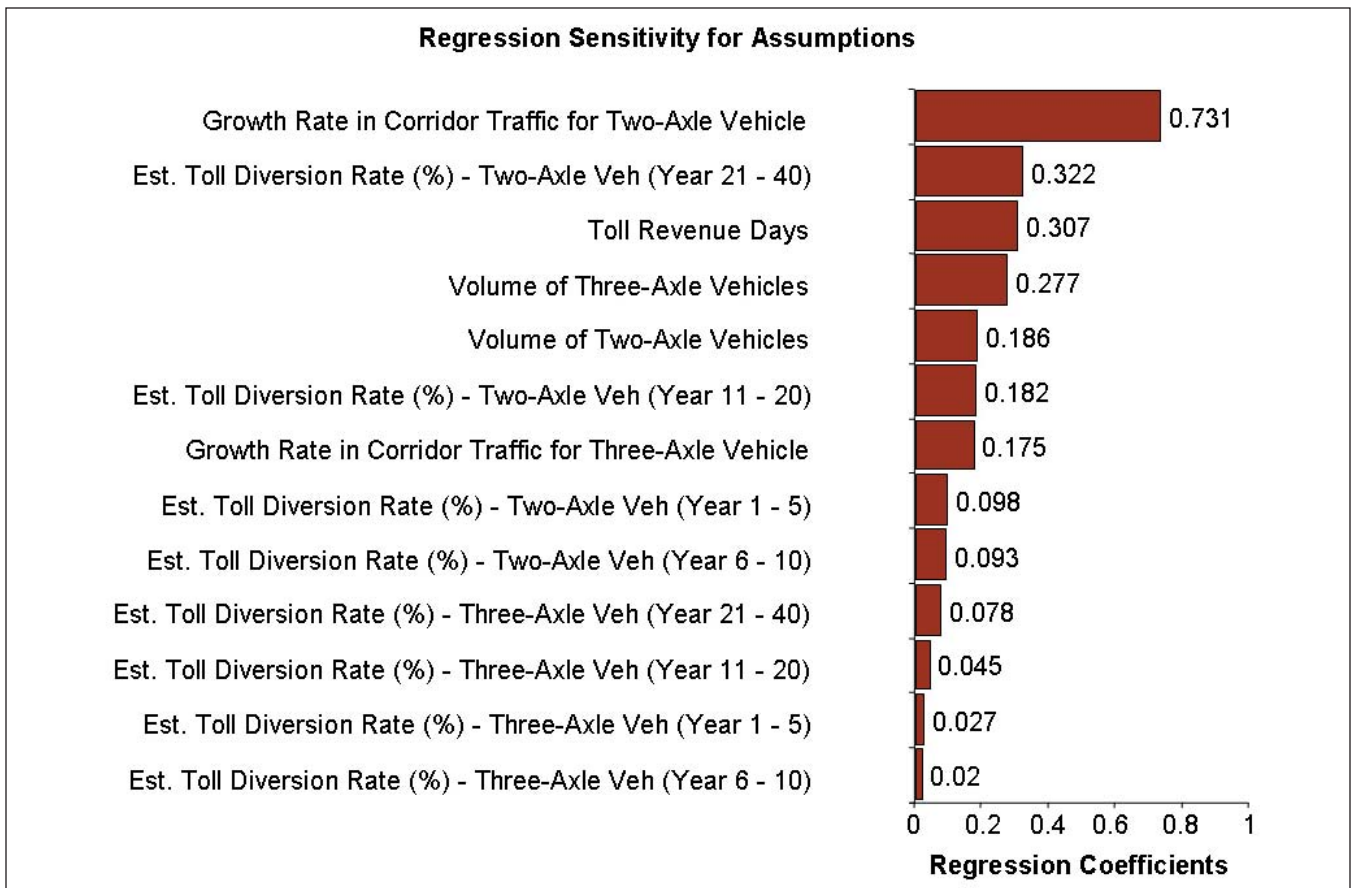


Figure 3. A Typical Tornado Diagram Showing the Assumptions with the Highest Impact on the Revenue Estimate.

- Net present value (NPV) of the revenue stream is presented in tabular form for the primary toll rate for each year of the project. In addition, the project-life NPV is shown for each of the candidate toll rates. This output may be useful for comparing the NPV of revenues with project costs in analyzing the overall financial feasibility of the project.
- Confidence intervals for the NPV at various initial toll rates are provided as a standard output. This output provides the analyst with a revenue range that is produced by the assumptions made and varies according to the starting toll rates chosen.

Tornado diagrams depicting the impact of key assumptions on the revenue estimate are a key element of the output (Figure 3). This graphic may be among the most useful in providing the analyst and decision maker with a sense of the reliability of the revenue estimate. Using the tornado diagram, the analyst can identify those assumptions (input variables) that have the greatest impact on the revenue estimate and then focus efforts on verifying the accuracy of the assumptions made.

For example, in Figure 3 the growth rate for passenger vehicles has more impact than anything else. This finding would prompt the analyst to reconfirm all possible sources of information for that growth estimate and refine as

needed. Another useful application of the tornado diagram is a logic check on some assumptions. According to the results in Figure 3, toll diversion rate in years 21–40 is very significant, but the diversion rate in years 1–10 is not. Such a logical inconsistency would prompt the analyst to reexamine relevant input data.

### The Researchers Recommend...

It is envisioned that this spreadsheet tool will be used at the district level, as a complement to the Preliminary Feasibility Tool issued by TxDOT to the districts. At a future time, TxDOT will decide whether to combine the two models into a single package.



## For More Details...

The research is documented in:

[Report 0-4726-1, \*Estimating Revenues Using a Toll Viability Screening Tool\*](#)

[Report 0-4726-P1, \*Toll Viability Screening Tool\*](#)

[CD 0-4726-P2, \*User Manual for Conducting a Gross Revenue Simulation Analysis for Toll Road Feasibility\*](#)

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## TxDOT Implementation Status—May 2005

TxDOT districts utilize a Preliminary Feasibility Analysis Tool developed by TxDOT's Turnpike Authority Division (TTA) in 2004 to perform conceptual-level screening analysis for assessing candidate toll projects. TTA is currently reviewing the TTI model to determine if, and how, any of its features could be incorporated into the TxDOT screening tool.

For more information, contact Andrew Griffith, P.E., RTI Research Engineer, at (512) 465-7403 or email at [agriffi@dot.state.tx.us](mailto:agriffi@dot.state.tx.us).

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