ABC Tool Weighs Alternatives

Matrix compares preferences two at a time to create ultimate priority listing for bridge designs

by Benjamin Tang, Oregon Department of Transportation and Toni L. Doolen, Oregon State University

The factors involved in deciding how and when to replace substandard and functionally obsolete bridges can be more complex than the decision to build a new structure. These factors also impact whether accelerated bridge construction (ABC) methods can be used to complete construction quickly to improve safety and minimize costs. A new software analysis tool can help decision makers assess alternatives with more confidence that their choices will be the safest, fastest, and most cost effective.

The tool was developed in an Oregon Department of Transportation (ODOT) pooled-fund study, TPF 5(221). Based on the analytical hierarchy process (AHP), it determines the best alternative using specific weighted criteria (Saaty & Vargas 2001). The various criteria are compared two at a time to develop ranked priorities and a final decision.

The process compares criteria and sets priorities and weights for each criteria based on the relative importance of one criterion to another. Matrices of weighted priorities are used to create utility values for specific bridge replacement alternatives. The weighted numerical results are compared for each alternative and used to identify a preferred alternative.

The process can also be used to help designers decide among material as well as design choices. By comparing various cast-in-place concrete designs, precast concrete designs, or steel designs, the user of the tool can identify the best alternative, based on the criteria included in the hierarchy for a particular bridge replacement or rehabilitation project.

A simple example of how the matrices and weighting can be applied to a decision can be seen at http://www.fhwa.dot.gov/publications/publicroads/11novdec/02.cfm.

Application to Bridges

ODOT's technical advisory committee developed a two-level hierarchy of criteria relevant to determining the best construction methods to apply to bridge replacement and rehabilitation projects. The highest level consists of five criteria, each of which is specified by two to nine sub-criteria (Figure 1).

One of the projects used to test the tool was the U.S. 52 Bridge over the Mississippi River

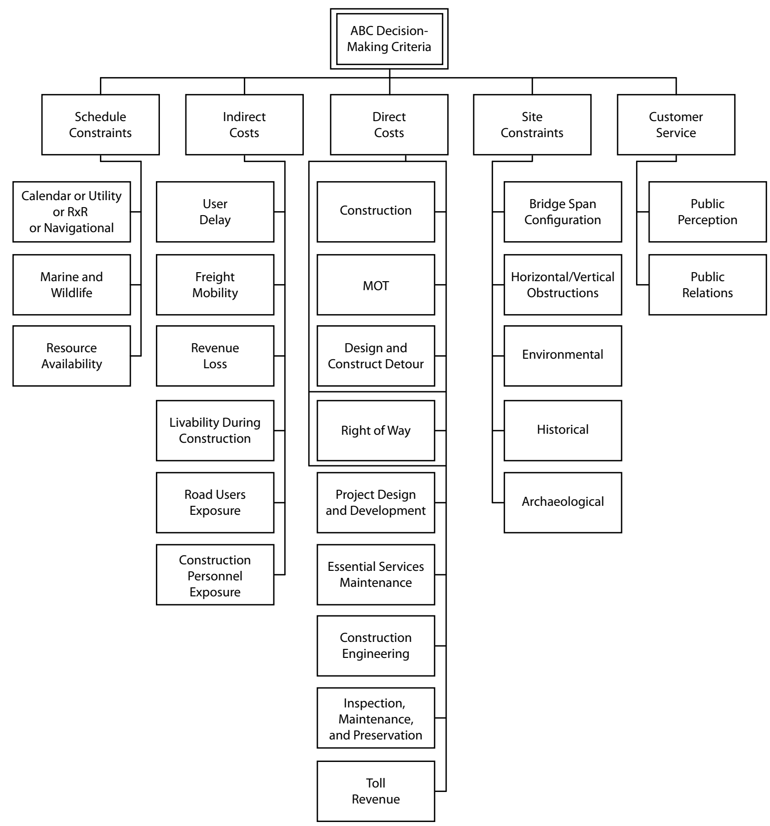

Figure 1: Decision criteria for bridge replacement or rehabilitation projects.

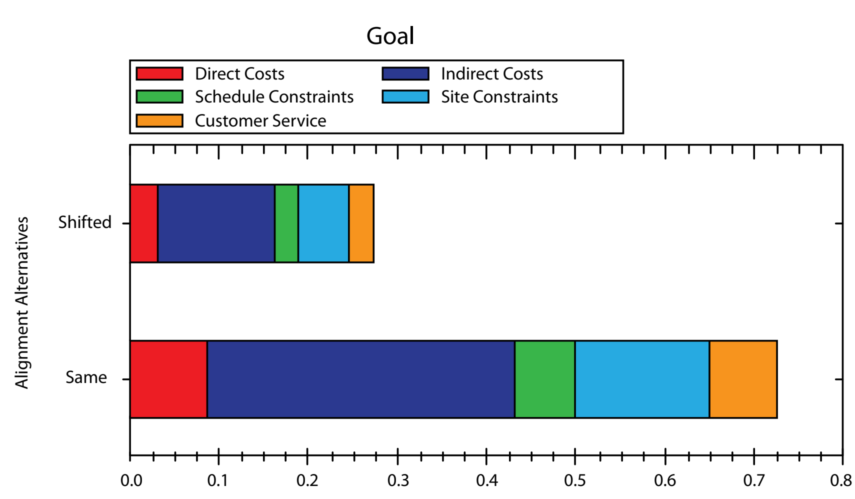

Figure 2: Overall priority for two replacement alternatives for Sabula Bridge.

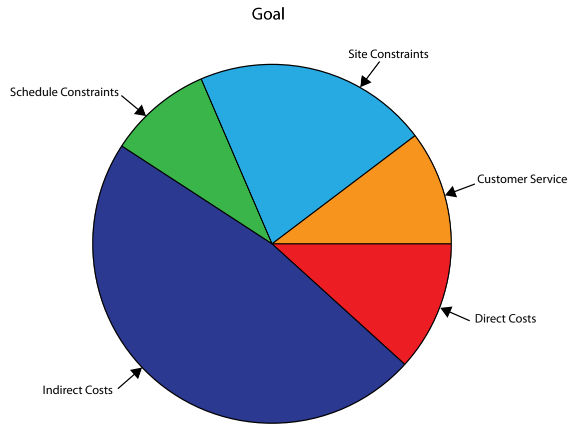

Figure 3: High-level criteria weights for Sabula Bridge.

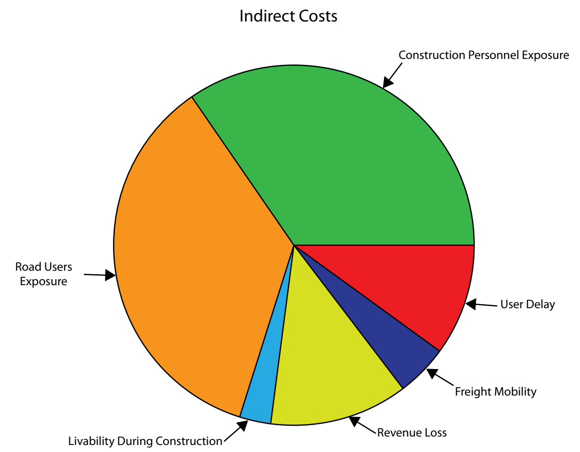

Figure 4: Sub-criteria weights for indirect costs for Sabula Bridge.

Overflow in Sabula, Iowa, which is functionally obsolete due to inadequate roadway width and clearance problems. The existing bridge is a 342-ft by 20-ft steel high-truss structure, for which the approach spans' deck was replaced in 1985.

There was no rehabilitation option available, so the bridge is being replaced. The required data for this analysis was provided by the Iowa Department of Transportation. Two construction alternatives were compared: same alignment with detour (ABC) and shifted alignment (conventional).

The AHP process was applied using the criteria shown in Figure 1 for these two alternatives. After completing the evaluation, the ABC alternative was preferred. The calculated overall priorities for the same and shifted-alignment alternatives were 0.727 and 0.274, respectively. Figure 2 summarizes the relative weighting of the five high-level criteria for this particular project. The size of each bar segment is based on the criteria weights resulting from the AHP analysis.

Figure 3 presents a top-level summary of criteria weights for the project. The results indicate that Indirect Costs and Site Constraints criteria have the greatest impact on the decision to select the same alignment alternative as the best alternative. Additional detail is also available, as a result of the analysis, which indicates the relative weighting of the second level criteria within each criterion, as shown in Figure 4 for indirect costs.

To date, the approach has been tested on projects in seven states (California, Iowa, Montana, Oregon, Texas, Utah, and Washington). It has proven to help decision makers clearly articulate the rationale for choosing an alternative by evaluating multiple criteria and diverse (sometimes opposing) perspectives. Using such a tool in a project's early stages can promote dialog and ultimately foster effective solutions.

Reference

Saaty, L. and Vargas, L. (2001). "How to Make a Decision," *International Series in Operation Research and Management Science*, vol 34, 1-25.

Benjamin Tang, P.E., is manager of bridge preservation for the Oregon Department of Transportation in Salem, Ore.
Toni L. Doolen, Ph.D, Oregon State University, is the principal investigator of TPF 5(221) Pooled Fund Study for the AHP Decision Tool.

EDITOR'S NOTE

For more information on the pooled fund study, visit www.pooledfund.org/Details/Study/449.