

Formal Methods for Evaluating Transportation Projects

By Lee Merkhofer, PhD.

Various analytic methods are available for evaluating and prioritizing transportation projects. The most popular are scoring methods, cost benefit analysis, and multi-attribute utility analysis.

With scoring methods, criteria are defined for characterizing the relative importance of transportation projects. For example, a project might get 5 points on a safety criterion if it “will eliminate a serious safety problem,” but only 3 points if it “addresses a documented safety problem of moderate nature.” Weights are assigned to the criteria based on their judged importance.

Simplicity is the strength of scoring methods. The major weakness is that they can’t be counted upon to produce reasonable project rankings. A review by the National Academy of Sciences called such methods “unsatisfactory, inadequate, undocumented, and biased.” The approach is best reserved for situations where all of the available alternatives are equally adequate and the primary need is to engage people in the decision-making process. Scoring methods should be avoided if choices made must be defended to people who did not participate in the scoring exercise.

Cost benefit analysis (CBA, also called benefit cost analysis) is popular because it invokes a persuasive logic—a project is worth doing only if benefits exceed costs. An attempt is made to identify and estimate all project impacts, such as reduced travel times for commuters and fewer traffic fatalities. Market prices or willingness-to-pay surveys are typically used to convert impacts into dollar values.

A criticism of CBA is that it ignores or inadequately values “intangibles.” For example, data showing that local property values don’t decline when a freeway interchange is built may miss impacts on community character and aesthetics. Also, willingness to pay is a function of wealth. The fact that a low-income community isn’t willing (able) to pay much to prevent an impact doesn’t necessarily mean that that impact is of little concern. The alternative to using market data is to obtain the required value judgments directly from elected officials, policy makers, or representative stakeholders. If the situation does not allow for this sort of input, CBA may be the only option. It is best used in situations where underestimation of benefits is unlikely to misinform decisions.

Multi-attribute utility analysis (MUA), also called multi-criteria decision analysis, is a high-bred approach that combines features from scoring methods and traditional CBA. Criteria (called “attributes”) for evaluating projects are formally derived from objectives. Care is taken to ensure that the objectives and associated criteria do not overlap, which would cause some benefits to be counted twice. Like CBA, MUA produces a dollar measure of project value (not just a point score), so projects can be ranked based on the ratio of benefit-to-cost. However, instead of using market prices to convert impacts to dollars, a value model (“utility curve”) is developed for doing the same based on a

technique wherein people express their willingness to make tradeoffs among various desired and undesired outcomes. The term “utility” in the name refers to the economic concept of utility; that is, a measure of desirability or usefulness.

Like scoring methods, MUA can capture virtually any concern or issue that people feel is important. Defensibility is a key strength—the National Academy of Sciences has called MUA “a satisfactory and appropriate decision-aiding tool.” The major disadvantage is that applications take skill. A specialist is needed to facilitate the MUA process. The approach is most useful for creating tools for prioritizing projects and as a collaborative process for resolving controversial decisions.

Example

The Oregon Department of Transportation used MUA to evaluate projects for easing traffic congestion along Highway 99W just outside of Portland. The decision of which project(s) to conduct was controversial. Various interest groups supported different solutions, including doing nothing, more bus service, rail systems of several types, and various locations for a freeway bypass. The goal was to engage stakeholders in a process that would narrow the options and promote consensus for a defensible solution serving all interests.

A 25-member committee, consisting of representatives from affected communities, special interest groups, and citizens, was established to participate in the MUA process. The analysis was conducted in four committee meetings, with between-meeting support from a team of technical specialists.

- At the first meeting, the committee developed and agreed upon 12 fundamental objectives. These objectives included satisfying the transportation needs of various categories of travelers; protecting health, safety, and the environment; protecting community socio-economic quality; and accomplishing the effort at a reasonable cost.
- In preparation for the second meeting, for each objective, technical experts developed a diagram (called an influence diagram) showing the project characteristics and other factors judged to influence or determine the degree to which the objective would be met. The diagrams included intangible issues and concerns as well as more readily quantifiable factors. At the meeting, the committee revised and refined the diagrams.
- Next, the technical specialists developed and collected data for the various project alternatives related to key factors in the influence diagrams. For example, a factor relevant to the objective of satisfying transportation needs was the amount of time spent in transit by various representative commuters. Transportation and population growth models were used to derive such estimates. In situations where quantitative estimates were not possible, qualitative estimates were provided. The

committee reviewed the estimates and requested additional inputs from the technical experts.

- An MUA model was developed for evaluating the alternatives. Scales were created for evaluating the alternatives based on factors in the influence diagrams. At the final meeting, weights for the model were derived for each committee member. Then, each member either accepted the experts' judgments or provided his or her own judgments for how each alternative would perform against each factor. The model was used to combine the weights and technical judgments so as to produce a personal ranking of the alternatives for each participant.

The results came as a surprise to many. Three of the alternatives (enhanced bus service, a freeway bypass, and inter-urban rail) ranked highest for nearly every participant. The members were given the opportunity to change their rankings, but none chose to do so. Evidently, they found the logic persuasive, most likely because they participated in the design of the model and the rankings were derived from their personal weights and assessments. The committee consensus recommendation was that further study should be limited to these three options. The highly-ranked freeway bypass project was ultimately selected and is currently being implemented.

Dr. Merkhofer specializes in models and tools for evaluating and prioritizing projects. His website, www.prioritysystem.com contains detailed articles on the subject.