Sensitivity Analysis of Multiple-Choice Decision Methods for Transportation

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Multiple-objective decision-making (MODM) processes are used to rate alternative plans and projects in order to find a preferred alternative or to set priorities among a set of projects. In this paper, the sensitivity of project rankings to various assumptions in calculation procedures used to rank alternative highway projects is tested. Issues addressed included methods of standardization, aggregation of weights and scores, and inclusion of a benefit-cost element. Results of the work indicate that project rankings arrived at through MODM techniques can be sensitive to computational assumptions. Failure to use standardization can have a major effect, whereas differences in standardization have some effect, and differences in weighting techniques have a moderate effect. The selection of criteria and their arrangement in a hierarchy are also critical; improper utilization can have significant unintended consequences. Unexpected turbulence and sensitivity of applied MODM models may be the result of their size and complexity, suggesting the need to reduce the numbers of criteria and alternatives.

The use of multiple-objective decision-making (MODM) techniques for transportation and highway problems is a commonly accepted approach for dealing with complex problems. These techniques are used to select preferred alternatives and to determine priorities for implementation among a set of projects. Although many attempts have been made to perform such analysis in a systematic way, no single technique has received widespread acceptance as an effective means to carry on this process *(1–3)*.

In this paper, some aspects of MODM methods are explored and a framework for applying MODM in transportation decision making is suggested. MODM presents a way to combine various performance measures of transportation projects into an overall indicator of the worth of a particular project. Each alternative project receives a score for its performance on a particular criterion. These scores are combined into a limited number of measures (often, one) that determine the selection of plans or projects. Examples of such techniques are the following: weighted sums, in which all criteria are standardized to one scale; rank-based techniques, which use ordinal ranking of scores and criteria rather than cardinal numbers; goal programming, which requires expression of trade-off values between criteria; and benefit-cost analysis, in which performance measures and impacts are reduced to dollar terms. These techniques have been used to select the best project or plan from a given set of options or to rank alternatives in order of priority for investment over time *(4–7)*.

This paper addresses a number of issues in the MODM process, including technical issues related to alternative computational procedures and general issues related to the selection and use of criteria. Sensitivity analyses are used to determine how results of a MODM are sensitive to the assumptions made in the computational process. The application and meaning of several sensitivity indicators developed for this purpose are explained.

This work is based on a study conducted for the Wisconsin Department of Transportation (WisDOT), examining procedures developed and applied in 1984 for major highway project prioritization (MHPP) *(8)*. Multiple-objective decision-making techniques were used to rank 38 possible projects using 36 criteria. Criteria were given in the following three groups: deficiencies in volume/capacity ratio, critical accident ratio, and no passing zones and road width; intangibles, including physical, traffic, route continuity, and positive and negative impacts; and benefit-cost, consisting of B/C ratio and net present value. Criteria were combined in stages using limited standardization and exponential weights. The result of the exercise was a recommended list of 15 projects to be considered by a committee of state legislators and citizens for implementation. The Wisconsin 1984 MHPP served as the basis for comparing different methods and techniques for multiple-objective decision-making.

ISSUES

Several reviews of different MODM models and techniques conclude that there is no one best or correct method *(9, 10)*. The present approach is to use a number of different MODM techniques to see how they affect the final results of an evaluation. Sensitivity analyses are conducted to measure how much impact a change in technique has on the outcome of a method. By comparing different methods of ranking alternatives, the difference in outcome between methods can be measured.

Four basic questions will be explored in this paper: (a) conceptualizing the decision issue, (b) standardizing scores, (c) combining weights with scores, and (d) examining the way in which the inclusion or omission of certain criteria (e.g., benefit-cost) affects the final outcome.

Problem Conceptualization

Correct conceptualization of the problem is perhaps the most critical step in MODM. What is the issue? What are the goals, objectives, and attributes related to the decision in question? What are the alternative courses of action? In the Wisconsin 1984 MHPP example, the goal was to invest the state's

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resources in that set of projects that were most effective in achieving a set of relevant objectives, at minimum cost. In the Wisconsin 1984 MHPP, three elements were used: deficiencies, benefit-cost, and intangibles. It is unclear, however, what the objectives were that these elements reflected. Accident reduction and a component of benefit-cost, for example, were included in the deficiency element.

This example illustrates two problems that often complicate analysis: dependence of objectives and double counting. MODM methods assume independence of criteria. As a result, criteria and attributes must be identified so that they are, in fact, independent. Thus, the presence of two elements, supposedly reflecting different and independent objectives, which both include the same attribute in different forms (e.g., one, the accident ratio, the other, the dollar benefits of accident reduction), is questionable.

Problem conceptualization should be undertaken interactively between technical staff and decision makers. A useful framework is the goals, objectives, and attributes hierarchy *(11)*. Such a hierarchy has an advantage in being useful for assigning weights to a large number of attributes. This can be done by assigning weights first among goals, then separately among the objectives related to each goal, and finally among the attributes or criteria related to each objective. In this manner, even if the total number of criteria is quite large, the number of comparisons is considerably reduced, and weights can be derived from pairwise comparisons between goals, subsets of objectives, and sub-subsets of criteria *(12–14)*.

Standardization

Standardization of attributes of alternatives (e.g., volume-capacity ratio) and scores (e.g., experts' ratings of prospective disruption potential during construction) is usual, but various standardization methods exist. Sensitivity analysis can examine whether the adoption of a different standardization technique such as standardization on a range versus standardization around the mean significantly alters the final ranking of alternatives.

Standardization on a range is done by converting raw values for weights or scores to a uniform scale such as from 0 to 1, using the range of raw values as the basis. Thus the lowest raw value is assigned a value of zero, the highest a 1, and values in between are given as decimals. This works fine as long as the raw values are reasonably distributed between the ranges. If there are some unusual values at the extremes of the range, standardization by range may result in some distortion of the standardized results. Another method is to standardize around the mean. In this case the standardized values are set to match the mean and standard deviation of the raw scores. Thus, with standardization on a scale of 0 to 1, the mean value of the raw data would be set as 0.5 and remaining values would be set to match their deviations from the mean in the raw data.

Aggregation

The choice of a method for aggregation of scores and criterion weights has not been resolved in the literature. A common approach is to aggregate by multiplying weights and scores and adding up values. An alternative approach suggested by Yager *(11)* involves using weights as exponents. Exponential weights express relative priorities of criteria more clearly, because they diminish low scores and magnify high ones. The resulting nonlinear preference function is perhaps more consistent with intuitive preferences than the linear function produced by a product, but there is no support for the inference that it is an exponential function that accurately expresses the preferences.

SENSITIVITY INDICATORS

In order to determine how sensitive the outcomes of MODM applications are to the factors discussed, several indicators of the degree of change in rankings of alternatives were developed. These indicators were Alexander's A, Beimborn's B, Patton's P, and Witzling's W *(3)*.

Alexander's A indicator is the sum of the squared differences in ranks expressed as a fraction of the maximum possible. Thus 0 represents no change, and 1 represents a complete reversal in ranks. Alexander's A, because it is a rank-order correlation measure similar to Spearman's r, has a known distribution, namely from 0 for a perfect positive correlation, through 0.5 for a random relationship, to 1.0 for a perfect negative correlation. Alexander's measure of sensitivity for method j is given by the expression

$$A_j = \frac{\sum_{i=1}^{N} (x_{i,j} - x_{i,j-1})^2}{\left[\sum_{i=1}^{N} (x_{i,j} - x_{i,j-1})^2\right]_{\max}}$$

where

$x_{i,j}$ = rank of alternative i for method j,
$(x_{i,j} - x_{i,j-1})$ = difference in rank for alternative i computed in two different runs j and $j - 1$,
$\left[\sum_{i=1}^{N} (x_{i,j} - x_{i,j-1})^2\right]_{\max}$ = maximum possible sum for all alternatives of the differences between two method ranks squared, and
N = number of alternatives.

Witzling's W indicator is the percentage of alternatives that exhibited a change in rank greater than or equal to 10 percent of the total number of alternatives. In this application, 10 percent is 3.8, so any alternative whose rank changes 4 or more is counted. The random value of Witzling's W (which is also standardized for any number of alternatives) is 0.828. That is, 82.8 percent of the alternatives would be expected to change by 4 or more ranks if the project prioritization were completely random. This result is surprisingly high, suggesting that the indicator is extremely sensitive to minor perturbations, perhaps limiting its usefulness. On the other hand, if even small differences in outcomes are significant in assessing differences between methods, Witzling's W may be a valuable indicator.

Witzling's measure of sensitivity for method j is given by the expression

$$W_j = \frac{\sum_{i=1}^{N} \delta_{i,j}}{N}$$

where

$$\delta_{i,j} = 1 \text{ if } (x_{i,j} - x_{i,j-1}) \geq 0.1N; \text{ or } 0 \text{ if } (x_{i,j} - x_{i,j-1}) < 0.1N$$

W_j is the number of alternatives for method j with a change in rank greater than or equal to 10 percent of the number of alternatives.

Beimborn's B indicator is the average change in rank for each alternative. Beimborn's B shows the average difference in rank but because it is related to the total number of alternatives, it tends to increase as the number of ranks grows larger. Here its minimum is 0 and its maximum is 18.42, and it has a random value of 12.76 (i.e., alternatives would change in rank an average of 12.76 places out of 38 if the rankings were done randomly). The position of its random value on this scale also suggests a heightened sensitivity to small changes, so it may be subject to the same qualifications as Witzling's W.

Beimborn's measure of sensitivity for method j is given by the expression

$$B_j = \frac{\sum_{i=1}^{N} (x_{i,j} - x_{i,j-1})}{N}$$

Patton's P indicator is the number of alternatives that move to either side of a preset cutoff point on the list of alternative projects. This point should be related to the specific decision problem. For the MHPP sensitivity analysis, P was defined as the number of projects that switched places with the top 15 projects on the final priority ranking. Patton's P indicates the net effect of a specific change in the MODM process on project selection. For example, if only the top 15 alternatives are selected, Patton's P indicates how the analytic procedure being tested affects the group of projects chosen.

Patton's P indicator varies depending on the number of alternatives and the chosen cutoff line. In the example, Patton's P ranged from 0 to 15; a value of 0 meant that the same set of

TABLE 1 SENSITIVITY ANALYSIS

FINAL RANKS FOR EACH METHOD:

ALT. NUM	METHOD 0	METHOD 1	METHOD 2	METHOD 3	METHOD 4	METHOD 5	METHOD 6	METHOD 7	METHOD 8	METHOD 9	METHOD 10	METHOD 11
1	28	12	26	18	27	16	31	14	12	16	15	15
2	4	10	2	4	5	9	6	5	5	3	4	4
3	23	29	21	27	15	27	20	27	29	28	29	29
4	12	7	18	11	21	18	13	17	10	11	13	14
5	24	26	30	29	26	28	21	28	26	30	28	28
6	11	16	13	20	9	22	7	19	17	18	23	17
7	29	5	32	9	32	5	25	3	4	7	6	1
8	1	1	3	1	12	1	5	2	1	1	1	2
9	9	24	8	22	10	20	8	21	24	23	21	22
10	19	13	25	6	31	3	26	4	8	12	9	13
11	22	18	27	14	29	19	29	24	22	20	20	26
12	13	8	15	10	13	10	15	10	11	8	7	8
13	5	23	4	19	2	21	2	16	21	21	22	20
14	8	20	10	17	3	12	4	9	18	17	17	6
15	7	2	9	5	8	6	9	6	6	5	5	7
16	20	27	22	28	16	26	14	23	27	26	26	19
17	2	25	1	24	1	25	1	25	25	24	25	24
18	6	6	6	3	6	4	10	13	2	4	3	9
19	3	3	11	2	11	2	3	1	7	2	2	3
20	26	11	19	12	17	8	33	18	13	10	8	18
21	14	30	5	26	4	30	17	32	30	27	27	33
22	31	19	31	21	23	17	36	20	20	19	16	21
23	15	17	14	13	22	13	23	22	16	13	12	23
24	33	37	24	36	25	36	27	35	37	37	36	35
25	36	21	36	25	35	22	30	15	19	25	24	16
26	21	33	17	33	14	34	16	34	33	31	32	34
27	37	35	37	37	38	37	37	37	35	36	37	37
28	17	22	12	23	20	24	24	26	23	22	19	25
29	25	32	29	31	28	29	19	29	31	32	31	27
30	16	15	16	15	18	14	12	11	15	15	18	10
31	32	4	23	7	34	7	38	7	3	6	10	11
32	27	36	28	35	24	33	22	33	36	35	34	32
33	10	14	7	8	7	11	11	12	14	9	11	12
34	38	38	38	38	36	38	34	38	38	38	38	38
35	34	9	33	16	37	15	32	8	9	14	14	5
36	35	34	35	34	33	35	35	36	34	33	35	36
37	18	28	20	30	19	31	18	30	28	29	30	30
38	30	31	34	32	30	32	28	31	32	34	33	31

projects remained in the top 15 with perhaps different ranks, whereas a value of 15 meant that a totally different set of projects had moved into the acceptable groups as a result of the factor being tested. The random value for Patton's P in this case was 8.95, or about 60 percent of its maximum value. That is, if ranks were set randomly, an average of 9 alternatives would switch into and out of the top 15.

APPLICATION AND FINDINGS

The 1984 Wisconsin MHPP was used to test the sensitivity of various MODM techniques. WisDOT ranked 38 possible highway projects using 36 criteria to be considered by a committee of state legislators and citizens for implementation. The model for this process used limited standardization of scores, exponential weights, and several intermediate steps to combine criteria. The criteria were combined in a series of modules. For example, one of these was the benefit-cost module that combined a benefit-cost ratio with a net present value to produce a composite score. These values were combined with others in a series of steps to develop a priority ranking for all the projects. Approximately the top third of the proposals were then recommended for implementation to the Wisconsin State Transportation Projects Commission.

For this analysis, the process used in the 1984 Wisconsin MHPP was systematically modified 11 times and tested to see how the use of different techniques affected the final ranking of alternatives. Project priorities resulting from each application are presented in Table 1. Here, for example, Alternative 1 was ranked 28 using Method 0 (the 1984 Wisconsin MHPP), but ranked 12 using Method 1, and so forth. Each application method represented a different combination of standardization technique, weighting aggregation, and other factors.

These rankings were compared using the four sensitivity indicators developed for this purpose. The sensitivity measures of paired comparisons of these methods are of interest in estimating the effects of changes in standardization methods, aggregation of weights and scores, and problem conceptualization. The findings of this sensitivity analysis *(8)* are presented in Table 2.

Standardization

For all four sensitivity measures, use of standardization produced significant changes in project rankings. Relative to the existing WisDOT model, roughly two-thirds of the rankings changed more than three ranks and the average change in rank was roughly eight. Seven projects in the original top 15 were replaced by 7 others.

Sensitivity measures remained at roughly the same levels whether scores were combined with coefficient or exponent weights. Use of standardization appears to account for more impact on rankings than differences in how standardization techniques or weights are applied.

It is interesting to compare standardization around a mean and standardization on a range with different aggregation techniques. With exponential weights (Methods 1 versus 8), both standardization techniques have similarly high impacts. When coefficients are used (Methods 3 versus 9), standardization based on ranges has a greater additional impact than standardization around the mean. In other words, standardization around the mean when compared with standardization based on the range is more likely to change rankings in the same direction as the use of coefficients.

Clearly, the two tested techniques for standardization have significant impacts on the final outcome. Although their impacts differ, the difference is minimized when the standardization techniques are combined with the options for other aggregation algorithms.

The choice between the two techniques should rest on an understanding of their conceptual differences. Standardization around the mean converts the set of numbers into a new set of positive numbers that approach a mean of 50.0. Thus all categories are on an equal footing. However, standardization around the mean shifts the relative value of numbers within a category depending on the amount of variation as measured by the standard deviation.

Both techniques recognize relative values and make them comparable across categories. Standardization around the mean is mathematically more complex, but it maintains consistency across categories.

Weights—Exponential or Multiplicative Coefficients

The literature review did not provide any clear resolution of the question whether weights should be exponents or multipliers. The majority of researchers appeared to favor weights as multiplicative coefficients. The argument for exponential weights rests more on the possibility of nonlinear preferences than on any demonstration that such preferences are in fact exponential in form.

Wisconsin's 1984 application of MODM to a major highway project prioritization used exponential weights, and this became the basis of the present comparison with alternative approaches. Exponential weights were used in Methods 1, 4, 6, and 8, whereas coefficient weights were used in Methods 2, 3, 5, 7, 9, 10, and 11. None of the applications appeared sensitive to differences in weighting, according to all indicators. There appeared to be some moderate effects from the different weighting approaches. When scores were not standardized, 39 percent of the alternatives changed rank by 10 percent or more, the average change in rank was 3, and only 1 project dropped out of the top 15, because of the change of weights from multiplicative coefficients to exponents. When scores were standardized around the mean, sensitivity was even lower; A was only 0.01, W only 34 percent, and the average difference in rank only 2. Again, only 1 project in the top 15 was switched.

The Benefit-Cost Element

In the case study, some aspects of the decision model appeared problematic. The use of the benefit-cost element, which combined benefit-cost ratio and net present value (NPV) for each alternative into an aggregate score, raised questions of double counting and decision relevance. The inclusion of attributes such as accident reduction elsewhere (as a critical accident ratio under the deficiency module, and as monetary benefits in the benefit-cost ratio and NPV under the benefit-cost module)

TABLE 2 SENSITIVITY ANALYSIS SUMMARY

	Indicator			
Comparison	A	W	B	P
Standardization vs. No standardization				
with exponential weights	0.28	0.74	8.63	7
with coefficient weights	0.24	0.71	8.42	8
Standardization by mean vs. Standardization by range				
with exponential weights	0.27	0.21	1.26	0
with coefficient weights	0.01	0.05	1.26	1
Exponential weights vs. Coefficient weights				
with no standardization	0.03	0.39	3.00	1
with standardization by range	0.02	0.47	2.63	2
with standardization by mean	0.01	0.34	2.00	1
Benefit-cost omitted vs. Benefit-cost included				
with exponential weights	0.04	0.66	3.36	2
with coefficient weights, standardized by range	0.03	0.34	2.37	2
with coefficient weights, standardized by mean	0.05	0.42	3.47	2
Random values	0.50	0.83	12.76	9

also may be a double counting. The hypothesis that, because of low weights assigned by the experts consulted, the benefit-cost element was no longer decision relevant also should be tested. The results would be significant because the benefit-cost element was the only element in which project cost appeared as a relevant factor.

Omission of the benefit-cost element proved to have a moderate effect on the ranking of alternatives. When judged by Alexander's *A*, the sensitivity of this factor was low, ranging from 0.03 to 0.05 depending on other techniques applied. For Witzling's *W*, Beimborn's *B*, and Patton's *P*, the sensitivity values were also well within the sensitivity ranges displayed by purely technical variations in standardization and aggregation methods. This outcome, probably unintended on the part of participating decision makers, may be the direct result of the relatively low weight many of them gave to the benefit-cost module, not realizing, perhaps, that this would lead to cost becoming an unimportant, indeed almost irrelevant, factor in the final choice among projects. It may also be the result of the large number of criteria that may lead to each factor's receiving a rather small weight if they are not carefully arrayed in a goal-related hierarchy.

The practical meaning of these findings hinges on the interpretation of the sensitivity indices. Alexander's *A* indicator measures the aggregate effect of a factor on the correlation between two sets of rankings, and the sensitivity to the various factors measured in our tests according to this measure was relatively low. But if absolute changes in rank of specific alternatives are of interest, then even small values of Witzling's *W*, Beimborn's *B*, or Patton's *P* are significant. By this standard, any variation in approach produces considerable turbulence, and the model appears to be sensitive to combinations of factors that are inexplicable and may, indeed, be random.

Conceptual Model and Selection of Criteria

The observed effects of the benefit-cost module on the process and its outcomes raise questions about the appropriate criteria and how they are combined. The choice and arrangement of criteria to be used for decision-making is perhaps one of the most critical phases of the evaluation process. Criteria should be selected according to the following general rules:

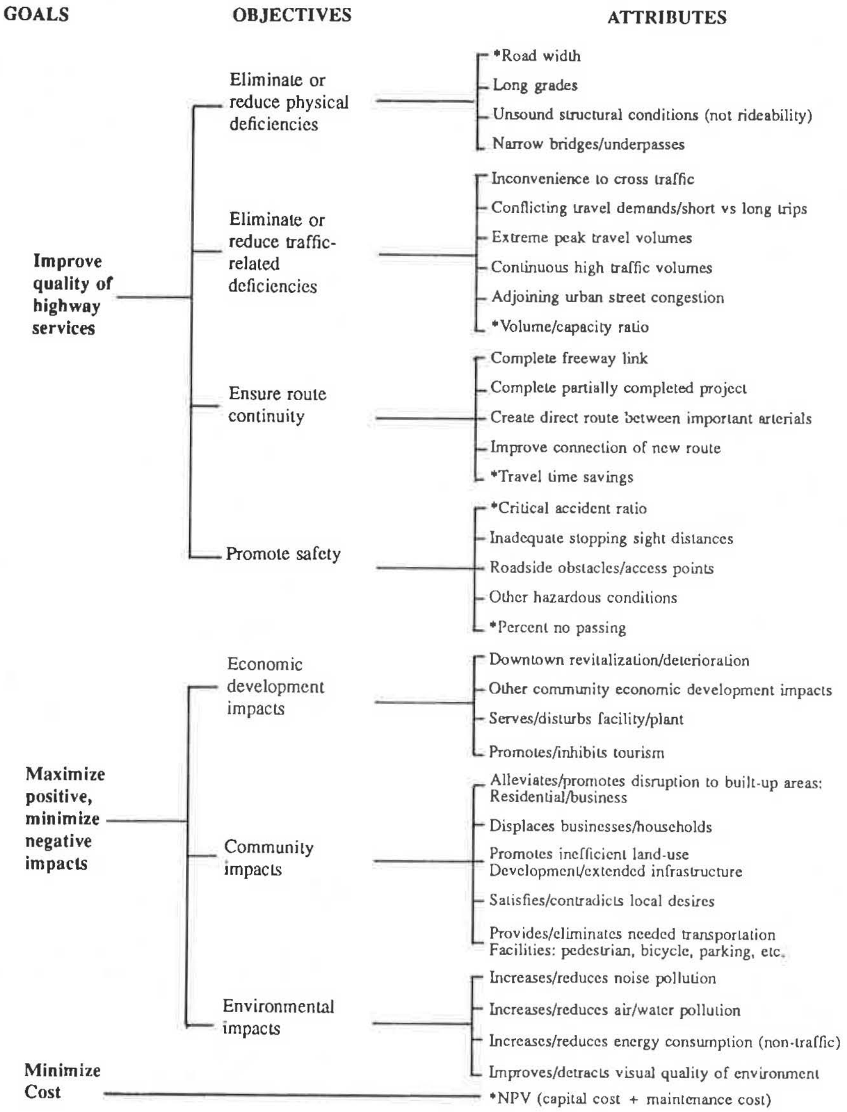
1. Goal orientation. Criteria should be selected so that they directly relate to the goals involved in the decision process. Criteria are meant to be indicators of how well goals are being met and should be carefully examined to see that they reflect the goals of an agency or project.
2. Decision relevance. Criteria should be used to measure significant differences between alternatives. Only criteria with significant differences between alternatives should be used for decision-making.
3. Independence. Criteria should be independent of each other insofar as possible. Criteria should be examined to avoid double counting of the same information. If criteria appear to measure the same things, they should be combined into composite measures. As pointed out in Rule 1, a good structure of goals helps to avoid double counting.
4. Predictiveness. The final rule relating to criteria is that they are used to predict how well a given alternative will do in meeting goals. Criteria should measure the net change in performance that is expected if an alternative is implemented.
5. Robustness. Although robustness is not a criterion for the selection and organization of decision-related factors, it is a criterion for a decision-making model as a whole. To be useful, a decision-making model must be sufficiently robust for choices to be unaffected by irrelevant factors or by random

relationships or interactions between variables or elements of the model.

The decision factors in a MODM method should be arrayed in a hierarchy of goals, objectives, and decision criteria. An example of applying these principles in such a hierarchy is shown in Figure 1. The basic goals are to improve the quality of service, maximize positive and minimize negative impacts, and minimize cost. Those criteria that relate to the quality of service of an alternative (its effectiveness) are placed together under separate objective categories: reduction of deficiencies, traffic flow, route continuity, and safety. Criteria that relate to impacts are grouped together under economics, community, and environmental impacts. Finally, cost is kept separate in order to permit comparisons on a cost-effective basis. This framework does not use the benefit-cost relationship as a separate criterion because the benefit-cost ratio has cost as only one of its components and also leads to double counting of benefits assessed elsewhere, such as safety and user time savings. The overall framework proposed here is intended to identify trade-offs between quality of service, impacts, and costs.

Review of the complexity and scope of MODM applications is desirable in nearly all cases. There is no substitute for clear thinking about the decision, its trade-offs, and the implications of various steps in reaching a conclusion. This conclusion is demonstrated in the MHPP application by signs of oversensitivity and perhaps even random turbulence, the results of the large number of alternatives and decision variables involved, and the process used. If the user agency is concerned with the sensitivity of the MODM model and the likelihood with which one alternative may shift from one side to another of the budget cutoff line, with only minor variations in procedure or for no accountable reason at all, then serious consideration should be given to reducing the scope of the model.

The easiest way to reduce the scope of the model is to reduce the number of alternatives that are systematically evaluated in



**Quantitative measure; others, qualitative assessments.*

FIGURE 1 Illustrative goals, objectives, and attributes hierarchy for MHPP.

each run. This reduction can be accomplished in several ways, including subgrouping (i.e., ranking the top, middle, and lower thirds separately, where each subgroup is previously determined), iterative subgrouping and sensitivity analysis (i.e., using a simplified MODM model to allocate projects to subgroups, and then to rank in subgroups, with each iteration tested by sensitivity analysis), and focusing on a limited number of projects around the budget breakpoint.

A conceptual hierarchy for which decision factors are clearly differentiated and independent also enables sensitivity testing of decision variables. This procedure can be used in an iterative and interactive process with participating decision makers effectively to reduce the weights of relatively marginal indicators to zero, thus eliminating them and simplifying the model. Reduction of the number of decision variables in this fashion could make a significant contribution towards developing robust and effective MODM models.

CONCLUSIONS

Computational and conceptual assumptions can have major effects on the outcome of a MODM process. In this paper, the ways in which assumptions made regarding standardization of input data, aggregation of data, inclusion or omission of certain criteria, and the overall arrangement of criteria affect the outcome of an evaluation exercise have been examined. The investigation was performed through a sensitivity analysis of the 1984 Wisconsin MHPP. The following conclusions could be drawn:

1. The failure to standardize data on a common scale can have a major effect on project ranking and prioritization. Project rankings shifted an average of approximately 8 places with over 70 percent of the projects shifting places by 10 percent or more from the effect of standardization. The *method* of standardization had a small effect. Standardization on a range or standardization on a mean led only to an average change in rank of 1.5, or only approximately 20 percent of the alternatives shifted rank by 10 percent or more.

2. The use of various methods for aggregation has a moderate effect on project results. Rankings changed an average of 2 to 3 places with 34 to 47 percent of the alternatives shifting by 10 percent or more in their position due to changing the method of aggregation from weighting by multiplicative coefficients to weighting by exponents.

3. Information can easily get lost in a MODM process. Elimination of benefit-cost as a criterion (therefore ignoring project cost) in the valuation had little effect on the final outcome. In an MODM process, special care to understand how criteria and alternatives interact must be taken to ensure that results are logical and relate to intentions.

4. There is a need to carefully examine the hierarchy of goals, objectives, and criteria. A general framework that clearly separates criteria is needed to avoid double counting and lead to logical combinations of criteria.

5. Finally, this paper has demonstrated the need for care in application of MODM techniques. It is important to conduct sensitivity analysis on a process to ensure that computational assumptions or conceptual flaws do not bias the results. There is no substitute for sound judgement in decision making. MODM techniques can be an aid, but should not be used without a great deal of care and skepticism.

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