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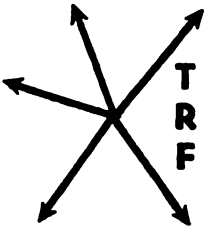

TRANSPORTATION RESEARCH FORUM

A Procedure for Selecting and Prioritizing Objectives for Regional Transportation Planning

*by Neil B. Mills**

With the increased involvement of regional planning agencies in transportation development, there has arisen the need for a systematized procedure for selecting and prioritizing objectives for regional transportation planning. This paper suggests that attitudinal responses from various sectors can be collected and statistically analyzed, thus compiling in order of priority an array of objectives that reflects the transportation needs of an area.

REGIONAL PLANNING COMMISSIONS, known by a variety of names, have been in existence in the United States for several years to promote orderly area development. But, with the passage of the Intergovernmental Cooperation Act of 1968, many of these regional organizations assumed widely expanded responsibilities in connection with federally assisted projects. More than 300 of them have been designated as "A-95 Clearinghouses" by the Office of Management and Budget's Circular A-95. This designation requires the review of applications for about 100 federally assisted programs by an A-95 clearinghouse as a condition of federal funding. Included in this review requirement for federal assistance are several programs for transportation development.

In September 1970, the Department of Transportation requested each state to prepare a study of its total transportation needs. These reports from the various states were the basis for the *1972 National Transportation Needs Study,* which is intended to guide our national transportation development to 1990. The Department of Transportation has urged the states to utilize urban and regional planning groups in identifying future transportation needs.

As a result of area growth and increased responsibilities for coordinated development, regional planning organizations have become increasingly involved in transportation planning. In order to intelligently review requests for federal funding assistance, and to insure the best possible future service for planning district residents, several regional agencies have recognized the need to prepare a comprehensive plan for the development of transportation in their territories.

As the first step in the preparation of a regional transportation plan, staff planners have been confronted with the task of selecting, an appropriate goal and objectives. In differentiating between these two terms, the trend has been to adopt definitions similar to those of the Department of Transporta-

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tion. With only slight modifications, these are the definitions that will be used in this paper which are stated as follows:

(1) A goal is a general statement of desired achievement that indicates actions necessary to cause the attainment of the end values toward which the planning effort will be directed.

(2) An objective is a component of a goal that is stated in such a manner that its attainment can be recognized and its progress toward goal accomplishment can be appraised.

Normally, a single comprehensive goal should be sufficient for a regional transportation planning activity. It should not be difficult to structure, and it should reflect the needs of area residents. A typical example of such a goal is that adopted by the Transportation Committee of the Central Shenandoah Planning District Commission in Virginia as follows: "To plan for and promote the development and maintenance of a transportation system that has the capability to transport people and goods in a convenient, efficient, and safe manner while disturbing the social and natural environments as little as can be reasonably expected."

The selecting and prioritizing of objectives in transportation planning are more complicated than the structuring of a goal. Individual objectives have varying levels of significance to different sectors of society, and there may be a wide divergence of values among different elements of a single sector. One group may emphasize increasing transportation safety while another is more interested in minimizing costs. These differences must be reconciled, and each objective must be viewed in its proper perspective. This task of appraising each objective is the responsibility of the regional transportation planner. The problem is to systematize the procedure in order that all interests in the region are given weighted consideration in the ranking of objectives.

This paper is not concerned with the planning process beyond the consideration of transportation planning objectives, and, the problem of goal selection is not addressed beyond the brief recognition just given. Rather, it is assumed that most goals in regional transportation planning will encompass the attributes of convenience, efficiency, safety, social tranquility, and environmental protection.

The problem of multiple objective selection and prioritization in regional transportation planning must be investigated in both breadth and depth. It is the stated objectives that guide the plan and its subsequent action, and the plan should strive to optimize transportation services for those it serves. So, the problems and the effects of appraising objectives are pervasive, and they should be examined accordingly.

Each working day the regional planning councils in the United States are tasked with judging the merit of applications for federal assistance in funding transportation developments. With increasing frequency, state planning agencies are becoming concerned with the development of balanced transportation systems, and they turn to their regional planning councils for an expression of needs. These assignments mandate the requirements for a listing of prioritized objectives for every regional planning activity that is involved.

The urgency of this problem can be reflected in any area with an unplanned development of transportation facilities. Where transportation has developed without intra-regional coordination, it is apparent that the need for transportation planning, guided by prioritized objectives, is immediate.

The adoption of a systematized procedure for selecting transportation planning objectives will have an immediate impact upon those planning agencies that subscribe to the system. It will be possible to draft better plans in less time when the initial step of objective selection has been reduced to a routine process.

The ultimate and most significant impact of the selection of the appropriate transportation planning objectives will be on the residents of the planning region. If objectives are selected to express the needs of transportation users, the attainment of these objectives necessarily fulfills the needs of transportation users.

The methodology described in this paper should be applicable to any planning region that has occasion to designate and evaluate transportation planning objectives. While the specific objectives and their relative importance will vary, depending upon the characteristics of the region, the procedure for selection and ranking should have general application.

The economic implications of adopting this procedure are varied and several. Initially, an economic benefit will be realized by those planning staffs seeking a point of departure for preparation of comprehensive regional plans for coordinated transportation development. This procedure can be used to identify an array of transportation planning objectives that are generally applicable to any region, thereby conserving the efforts of the several staffs who might otherwise perform this time consuming task on an individual basis. Even if the objectives identified did not reflect the needs of a particular region, the procedures developed could be systematically applied to any set of objectives, and the savings in time and expense to the planning staff would be substantial.

The economic implications to the public at large that result from a reflective transportation development are boundless. Presumably, each sector of society will express its transportation requirements so that the fulfillment of those requirements will be to its economic advantage. The coordination and synthesis of these needs, expressed in weighted measures, can only result in the economic betterment of the area served. Today, there are a multitude of public concerns for transportation development, all with economic implications. The purpose of any plan for regional transportation development is to satisfy these multiple objectives to the fullest extent. But, the first step is to identify, analyze, and appraise these multiple objectives.

Environmental considerations should not be omitted in transportation planning, and they can be reflected in the ranking of objectives. It is certain that conservation of the environment is one of the objectives of every concerned citizen, whether he is contemplating transportation development or some other evolutionary change. But, while this factor should not be ignored, its consideration should be in relation to the other objectives of transportation development.

This procedure calls for accumulating data in two stages. The first stage involves the collection and compilation of a comprehensive list of possible transportation development objectives. The second stage embraces the collection and compilation of responses to those objectives as adequate vehicles of guidance for transportation development.

The initial listing of candidate objectives can be compiled from various policy statements and plans that have been promulgated from the national and state levels. This group would contain such widely acceptable and varied motives as "Improve highway safety," "reduce pollution," and "improve transportation services." It is estimated that about ten non-controversial objectives, believed to reflect a cross section of the public's needs, would be included in this initial compilation. This list, together with pertinent inquiries, would be submitted in questionnaire form to the regional planning commissions in the area of study for their review and possible modification or augmentation. The responses from these questionnaires can be used to finalize the array of objectives to be considered for subsequent data collection.

Realizing that the requirements for transportation development vary among the sectors of our society, the finalized list of objectives would be submitted to individuals in government, industry, and the public for their evaluation and expression of relative merit. Using paired comparison techniques, data would be collected by briefed enumerators. Each respondent would be requested to state his preference of one objective over another for each of the pairs of objectives. These preferential indications should reflect the transportation needs of the area and provide meaningful data for further analysis.

As a minimum, the data to be used should be collected from a sample of government, industrial, and public sources. Each individual polled should be asked to indicate a priority of each objective over every other objective. The number of indicated preferences will be equal to $n(n-1)/2$ where "n" is the number of objectives. For instance, if there are six objectives, the number of paired comparisons will be $6(6-1)/2$, or 15.

The statistical procedure to be used is the non-parametrical paired comparison technique. As explained earlier, the data to be treated will be the collection of individual responses compiled from the indicated preferences of the respondents for each objective when they are paired with each of the other objectives. The responses from each sector of the sample can then be separately tabulated in matrix formats to indicate the rank order of preferences for each of the sectors. For instance, if the three objectives mentioned earlier (reduce pollution, improve highway safety, improve transportation services) were evaluated by ten traffic managers, each traffic manager would be asked to make the following three paired comparisons: reduce pollution versus improve highway safety; reduce pollution versus improve transportation services; and, improve highway safety versus improve transportation services. Hypothetically, the resulting thirty preferences might appear as set forth in Table 1.

In this illustration, three traffic managers preferred improved highway safety over improved transportation services. And, necessarily, seven traffic managers preferred improved transportation services over improved highway

HYPOTHETICAL EXPRESSION OF PREFERENCES OF OBJECTIVES BY TEN TRAFFIC MANAGERS

	Reduce Pollution	Improve Highway Safety	Improve Transportation Services	Total
Reduce Pollution	—	6	8	14
Improve Highway Safety	4	—	7	11
Improve Transportation Services	2	3	—	5
Total	6	9	15	30
Rank Order	3	2	1	—

TABLE 1

safety. Of the total responses, fifteen preferred improved transportation services, nine preferred improved highway safety, and six preferred reduced pollution over either of the other choices.

The next step is to determine the percentage of respondents' preferences for one objective over each of the others. This is accomplished by dividing the number of each preference by the number of respondents. In this example, the following matrix would result.

Table 2 illustrates that 40 percent of the traffic managers preferred reduced pollution over improved highway safety, while 60 percent of them expressed preferences for improved highway safety over reduced pollution. Likewise, 80 percent of the respondents preferred improved transportation services over reduced pollution and 20 percent of them preferred reduced pollution over improved transportation services.

The next step is to develop a scalar value for each of the objectives. As it is assumed that the distribution of intensities of reactions to each objective is normal, this can be accomplished through use of the "Z" statistic and a table of areas under the normal curve. The "Z" statistic is obtained by dividing the difference between the value of an item and the mean of the values of the sample of items by the standard deviation (i.e., $Z=(x-\bar{x})/s$).

PERCENTAGES OF RESPONDENTS' PREFERENCES OF EACH OBJECTIVE

	Reduce Pollution	Improve Highway Safety	Improve Transportation Services
Reduce Pollution	—	.6	.8
Improve Highway Safety	.4	—	.7
Improve Transportation Service	.2	.3	—

TABLE 2

Thus, the proportions in the preceding table represent the probabilities that standardized values (z) are greater than the "Z" statistics. To develop the scalar values of the objectives, it is first necessary to identify their standard values in a normal distribution. In this example, it was noted that 40 percent of the traffic managers preferred reduced pollution over improved highway safety. So, the probability that $Z<z$ is .4. As "z" is concerned with the proportion of total area between $\bar{x}$ and a given value of x, and in a normal distribution $\bar{x} = .5$, a value of .1 (obtained by subtracting .4 from .5) is used to enter a table of areas under the normal curve. In this instance, a value of .1 indicates a "z" of —.253. The "z" values are positive when the proportion is greater than .5, and negative when they are less than .5. Therefore, the probability that "Z" is less than —.253 is .4. After the "z" values corresponding to the other probabilities are determined, a matrix is formed with these statistics assigned to their respective objectives. The columns are totalled (with blank spaces counting as zeroes), and averaged. The smallest mean is then substracted from each of the means to develop the scalar values (the smallest scalar value will necessarily be zero). If common values are desired, they may readily be obtained by dividing each of the scalar values by the largest scaler value (the largest common value will necessarily be 1.0). The completed matrix will then appear as follows:

SCALAR VALUES AND COMMON VALUES FOR EACH OBJECTIVE

	Reduce Pollution	Improve Highway Safety	Improve Transportation Services
Reduce Pollution	—	.253	.842
Improve Highway Safety	—.253	—	.524
Improve Transportation Services	—.842	—.524	—
Total	—1.095	—.271	1.366
Mean	—0.365	—0.090	0.455
Scalar Value	0.000	0.275	0.820
Common Value	0.000	0.335	1.000

TABLE 3

The determined scaler values indicate the cardinal ranking of objectives. For example, the foregoing matrix indicates that improved transportation services is three times as preferential as improved highway safety. The common values can be used to compare the rankings of objectives by different sectors (e.g., industrial traffic managers and regional transportation planners).

This illustration is hypothetical and is not a prediction of observed preferences. It is merely used as a vehicle of explanation for the statistical procedures used in this paper.

Assuming the validity of the paired comparison model, the results of

the statistical analysis will indicate a scalar value for each objective as a measure of preference by the respondents of each sector of the area of study.

The common values will enable the comparison of preferences for objectives by the different sectors. They will provide the basis for measuring the attitudes of one sector of the area in relation to the attitudes of the other sectors on an objective.

Regional transportation planners can use the results of this statistical analysis in the selection and prioritizing of objectives for the planning of regional transportation development. The model is so structured that these planners can give consideration to the composition of their areas of study. If, for instance, an area is primarily residential, the indicated preferences of the public can be weighted accordingly. Each planning region must be appraised individually, and each planning organization must select and prioritize the objectives that best satisfy its requirements. This procedure will enable them to discharge that responsibility.