Development of Regional Multimodal Transportation Performance Measures for the Twin Cities

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Results of a study performed to develop measures for assessing the effectiveness of the transportation policies of the Metropolitan Council of the Minneapolis-St. Paul area are presented. The purpose of the study was to develop a set of performance measures for assessing the degree to which the Metropolitan Council's regional transportation policies were being adhered to and the extent to which the policies have been effective in attaining the basic objectives of the region. Two important innovations in the study were the emphasis on assessing versus management performance measures and the development of three sets of measures—one to provide an overview of transportation in the region, one to assess objective attainment, and the other to determine policy

2. The basis for this network should be an improved bus network that reflects service increases warranted by projected growth and applicable transportation system management improvements.

3. The background network must be modified for each line-haul facility or service alternative to provide appropriate interfaces and eliminate service duplications. Service duplications should only be eliminated to the extent that they could actually be eliminated. Experience with the Bay Area Rapid Transit system and the Washington, D.C., Metro system indicates that there may be substantial community opposition to the elimination of bus routes that, although they duplicate rail service, may offer a better level of service than rail or may provide local service that rail cannot provide. Bus routes that duplicate a proposed line-haul transit facility and that would offer service clearly inferior to that provided on the other facility can usually be eliminated or truncated without question.

4. No formalized attempt should be made in alternatives analysis to develop an optimal background bus network for capital-intensive facility alternatives. However, obvious modifications to the bus network should be made to provide adequate feeder and distribution services. At the conclusion of the analysis, supply-demand checks should be made to determine whether the services in the background network, especially feeder service, are in equilibrium. Furthermore, reasonability checks of riders per bus mile and riders per bus hour should be made to determine the relative productivity of the background bus network for different capital-intensive line-haul alternatives. These checks may indicate the need for refining the specification of the background network for a particular line-haul alternative. Usually, such refinements can be made manually without changing computer networks and repeating the travel demand forecasts.

5. Aggregation, or the schematic treatment of individual background bus routes, is appropriate for regional-level studies. In corridor-level studies, supply-parameter estimation and demand estimation will require more detail, and therefore the specifications for background bus networks should be at the level of individual routes or lines within the corridor under study.

CONCLUSIONS

Through an example, a discussion of general considerations, and detailed discussions of selected topics, this paper has attempted to reveal the complexity and significance of the estimation of transaction supply requirements in planning studies. Although the paper has been written in the context of federally required alternatives analysis studies, the principles and concerns raised are applicable to transit planning generally, particularly any planning efforts in which fixed-guideway transit modes are considered and alternative transit modes evaluated.

The paper is not comprehensive and has focused its most detailed discussions on selected inputs to the supply-parameter estimation process that require special attention. Many other important inputs to the process were not covered, and the entire subject of how these inputs are used to calculate supply-parameter estimates was not addressed at all. It is hoped that this paper will stimulate interest and further discussion of supply-parameter estimation among those planners actively involved in transit alternatives analysis studies.

ACKNOWLEDGMENT

This paper reports the results of research sponsored by the Transportation Systems Center and UMTA of the U.S. Department of Transportation. The views and recommendations presented, however, are mine and do not necessarily reflect the position of the research sponsors.

REFERENCES

The importance of urban transportation as a regional issue has long been recognized, and its implications for regional land use, economic vitality, energy consumption, and environmental quality have become more widely accepted. But in spite of the recognition of these relations, few regional planning agencies have been effective in influencing the development of a transportation system at the regional level guided by a clear set of transportation policies.

For many years, the Metropolitan Council of the Minneapolis-St. Paul area has recognized these interrelations and has been a leader among regional planning agencies in consciously addressing the issues. In 1975, the Metropolitan Council adopted a development chapter of its comprehensive Metropolitan Development Guide (1). As a means to help curb the uncontrolled spread of new urban development, the Development Framework defines a metropolitan urban service area (MUSA). It is now the policy of the Metropolitan Council that the bulk of new development and redevelopment is to occur within the MUSA through 1990. Similarly, investments in new urban services and facilities (including transportation) are to be concentrated within the MUSA line, to the extent feasible.

In 1976, the Metropolitan Council adopted a revised transportation chapter of its comprehensive Metropolitan Development Guide. The central focus of the Metropolitan Development Guide Transportation Policy Plan is on more efficient use of existing and concentrated transportation investments in the region. Among other things, it suggests that future highway and transit improvements should be scaled to serve off-peak rather than peak-period demand levels, that investments in new capacity should be concentrated within the MUSA delineated by the Metropolitan Development Guide, that transit services should focus on providing for travel within subregions and to the "metropolitan centers" rather than providing service between subregions, and that a wide variety of means should be considered for encouraging people to travel as passengers (whether in transit vehicles, taxis, or private automobiles) rather than as drivers.

When the Transportation Policy Plan was adopted, it was intended that the policies would be periodically reviewed and revised as necessary to maximize their effectiveness in meeting the basic objectives of the region. In August 1979, the Metropolitan Council initiated a program to develop performance measures that could be used in the evaluation of the 1976 Transportation Policy Plan. The result of this effort has been a framework for evaluating policy adherence, policy effectiveness, and objective attainment by using three basic types of performance measures.

This paper describes the framework within which performance measures were developed for the Minneapolis-St. Paul area and presents a discussion of the need for and the purpose of the measures. In addition, the measures that were developed by the Metropolitan Council are presented, and the issues related to the application of the measures in a performance review are discussed.

At the time this paper was written, the first phase of the project was complete. In that phase, the range of uses for performance measures was explored, a framework for developing performance measures was specified, and measures were developed for each of the three categories mentioned above. In the second phase of the project, which is to be completed in early 1981, details necessary for making the measures and the performance review operational will be explored. These issues will include a screening of the measures with respect to eight criteria, specification of a plan for the collection of the data necessary to apply the measures, and specification of a plan or schedule for performance review.

**PURPOSES AND USES OF PERFORMANCE MEASURES**

The primary purpose of the performance measure project was to enable the Metropolitan Council to evaluate its Transportation Policy Plan by determining (a) the degree to which the transportation policies were being followed and (b) the extent to which these policies were bringing about the attainment of the basic objectives of the region. More formally stated, the performance measures were developed to

1. Provide an indication of policy adherence,
2. Provide an assessment of the attainment of regional objectives,
3. Provide input into a periodic reevaluation of the transportation policies that would result in revisions of the existing policies as necessary, and
4. Aid in the evaluation of the regional transportation system.

In addition to the four primary purposes listed above, five other significant purposes were identified for which the performance measures could be used. They are

1. To monitor and evaluate existing transportation projects and services;
2. To review and evaluate proposed transportation projects;
3. To estimate the incidence of impacts of the transportation system on different socioeconomic groups and geographic locations;
4. To provide information for responding to inquiries from citizens, elected officials, and agencies about the performance of the transportation system; and
5. To provide a set of indicators of the state of transportation in the region.

It is important to point out that the measures that have been developed to satisfy the purposes mentioned above expand considerably on the types of indicators traditionally used to assess transportation performance. Measures such as cost per vehicle hour of service, cost per seat mile of service, or cost per person mile served represent just one component of a more comprehensive set of measures that take into account regional planning objectives in addition to the efficiency with which the transportation service is being provided. This is required since the policies developed by the Metropolitan Council often specify priorities of market segments to be served. The cost-effectiveness of providing the transportation services required to effectively serve a specific market segment may not be as favorable as for other types of transportation.
services that can be provided to the general population. In particular, demand-responsive services and other para-transit services provided for the elderly and the handicapped are an example of where cost-effectiveness measures may not be appropriate as an exclusive evaluation tool but should be considered in conjunction with more human-service-oriented measures.

FRAMEWORK OF PROJECT

The framework within which the performance measures were developed consists of three elements structured in a hierarchical relation: the regional objectives (derived from the transportation policies), the transportation policies, and the performance measures. This framework is shown in Figure 1. Each of these elements and the relation of the performance measures to each element are briefly discussed and elaborated on in subsequent sections of this paper. The regional transportation policies developed by the Metropolitan Council suggest the role that the transportation system can have in the attainment of the regional planning objectives. Careful examination of the 36 policies (of the 50 policies in the transportation policy plan, performance measures were developed for the 36 that were regional in scope) and discussions with the Metropolitan Council staff resulted in the identification of seven basic objectives:

1. Maintain and selectively increase accessibility and mobility,
2. Promote the effective use of existing investments,
3. Improve travel safety,
4. Promote positive social impacts,
5. Promote environmental quality,
6. Conserve energy, and
7. Promote positive economic impacts.

These objectives constitute the highest level of the performance measures development framework shown in Figure 1. At the next level in the hierarchy of Figure 1 are the 36 regional transportation policies. These policies represent Metropolitan Council statements of the role that the regional transportation system should play in attaining the seven objectives. The policies that share common themes have been grouped for simplicity of presentation into the following 14 policy clusters:

1. Concentrate transportation investments within the MUSA,
2. Place equal emphasis on transit service and investment within subregional areas and to and within the metropolitan centers,
3. Plan transportation services so as to encourage a self-sufficiency of subregional centers with less emphasis on intersubregional travel,
4. Reinforce the attractiveness and vitality of the metropolitan centers by providing a high level of transportation service to and within the centers,
5. Transportation services should be given highest priority in areas that have the greatest demand among persons dependent on public transportation (elderly, handicapped, youth, and low income),
6. Better use of the transportation system should be encouraged, emphasis should be placed on low-capital (transportation system management (TSM)) actions, and both the public and private sectors should be viewed as eligible service providers and as participants,
7. Transportation actions should promote the attainment of state and national environmental standards, giving priority to geographic areas that experience the most severe violations,
8. Safety considerations must be a major consideration in the planning, implementation, and maintenance of any transportation facility or service,
9. Transit actions that demonstrate the highest cost-effectiveness should receive priority consideration,
10. The concept of equity should be used to establish fare structures that reflect the operating cost of the service and the public purpose or need for the service,
11. Transportation facilities and services should promote and be consistent with the land use and development patterns specified in the Development Framework chapter of the Metropolitan Development Guide,
12. Transportation actions outside the urban service area should be limited to the specific needs of the free-standing growth centers and the rural town centers, consistent with the land use and development plans and policies of the region,
13. Innovative transportation demonstration projects should be tested and accompanied by a well-designed evaluation plan in order to assess the merit of continuing and/or expanding the project,
14. Transportation investments should be made on the basis of need and the ability of the metropolitan area to support these investments in relation to other metropolitan system needs and investments over time.

Each of the clusters is related to at least one of the seven basic objectives and is often related to several of the objectives. This relation is illustrated in Table 1 for a sample of the policy clusters. As Table 1 indicates, more than one policy cluster may be related to the same objective. It is for this reason that the complete set of policies and policy clusters must be evaluated in assessing how well the regional transportation system is promoting the attainment of the basic objectives of the region. Below the policies on the hierarchy of Figure 1 are the performance measures. These measures represent analytic tools for evaluating the extent to which the regional transportation system is consistent with the policies and, in turn, the objectives. It is important to note that it is possible to achieve policy adherence without necessarily attaining any of the basic objectives of the region. For example, consider the policy that states that the major share of transportation investments should be
concentrated within the urban service area. Although the rationale for this policy relates to one of the basic objectives of the region—namely, to promote the effective use of existing investments—simply measuring the pattern of investments does not provide an indicator of how well the regional land use and development plan is being achieved. Therefore, it is possible to concentrate investments in the urban service area and satisfy this policy without adhering to the land use and development plan, so that the objective implied by this policy is not attained.

For this reason, it was necessary to develop two types of performance measures for each policy: objective-related performance measures, which assess the objective attainment that results from adherence to a particular policy, and policy-related performance measures, which determine the degree to which the policy as specified is being achieved. Depending on the nature of the policy, the objective-related measures and the policy-related measures may be the same for a given policy. When the two are not identical, however, the policy-related measures should be used in combination with the objective-related measures to evaluate the policy under consideration. The arrows in Figure 1 illustrate that some performance measures would allow the Metropolitan Council to evaluate policy adherence and others would enable the determination of both policy adherence and objective attainment when the two are related.

In addition to objective-related and policy-related performance measures, a set of measures has also been developed that is designed to provide a limited perspective of the state of the region with respect to its transportation system. These measures, called overview performance measures, do not provide any direct indication of policy adherence or objective. They have a more specialized use and are discussed in a separate section of this paper.

DEVELOPMENT OF PERFORMANCE MEASURES

Objective-Related Measures

A set of summary performance measures was defined for each of the seven basic objectives. Each summary measure represents a general construct from which more specific performance measures can be developed. The summary measures make it possible to show in a simplified way the relations between them and the regional policies and to demonstrate how a performance measure in its general form may relate to several of the policies. This is important because it emphasizes the interrelations between the measures and the policies.

After it was determined which of the summary measures were applicable to each of the policies, based on the relations between the objectives and the policies, the summary measures were defined in greater detail to reflect more specifically the policy under consideration. In this way, a more meaningful measurement of that policy with respect to the related objectives could be achieved.

When an objective contained more than one category, performance measures were developed for each category. For example, the objective to "promote the effective use of existing investments" encompasses two categories—land use and the transportation system—both of which constitute existing investments. Performance measures were defined that addressed (a) the connectivity of the transportation system to specified land uses and (b) the basic effectiveness of the transportation system as an independent investment unit. The summary performance measures for this objective and three of the other objectives are given in Table 2 for example purposes. The complete set of summary measures for all seven of the basic objectives can be obtained either from the Metropolitan Council or Cambridge Systematics.

Several summary measures were developed for each category in order to provide a range of perspectives for evaluation purposes. Once again, if we use the objective relating to existing investments as an example, the connectivity between the transportation system and land use types can be measured by determining the percentage of the population within a specified travel time of the designated land use type. It can also be measured by determining the extent to which designated land uses are within a specified travel time of a certain percentage of the population. Both of these measures address the connectivity between the transportation system and the specified land use, but each portrays it in a slightly different manner.

The progression from the summary performance measure to a more detailed version of the summary measure in order to be more policy specific is presented for policy cluster 1 ("concentrate transportation investments within the urban service area") as an example. The two basic objectives that relate directly to this policy cluster are to "promote the effective use of existing investments" and "promote positive economic impacts". One summary performance measure that applies to this policy for the objective to "promote the effective use of existing investment" is the "population within a specified travel time of designated existing investment areas". To provide a more meaningful assessment of the policy with respect to this measure, a more detailed specification of the measure is developed. This may be the "change over time of the urban service area population within a specified travel time of designated activity generating geographic locations compared with the same change for residents outside the urban service area".
Table 2. Example of objective-related summary performance measures.

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<tr>
<th>Objective</th>
<th>Category</th>
<th>Summary Performance Measure</th>
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<tr>
<td>Maintain accessibility and mobility</td>
<td>Land use</td>
<td>Population (activities within specified distance of transit)</td>
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<td></td>
<td></td>
<td>Population within specified travel time of activities (geographic locations)</td>
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<tr>
<td>Promote effective use of existing</td>
<td>Land use</td>
<td>Travel times for specified origin-destination pairs</td>
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<td>investments</td>
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<td>Population within specified travel time of designated existing investment areas</td>
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<td></td>
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<td>Percentage of trips with destination at designated existing investment areas</td>
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<td></td>
<td></td>
<td>Percentage of designated existing investment areas within specified travel time of certain percentage of the population</td>
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<tr>
<td>Promote environmental quality</td>
<td>Air quality</td>
<td>Percentage of designated area within specified distance of a transit stop</td>
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<td></td>
<td></td>
<td>Change in assessed valuation (retail sales and employment) in designated areas</td>
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<td></td>
<td></td>
<td>Visual compatibility of transportation facility with adjacent land uses</td>
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<tr>
<td>Conserve energy</td>
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<td>Assessment of current (predicted) conditions relative to previous (current) conditions</td>
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<tr>
<td></td>
<td>Other natural resources</td>
<td>Contribution of specific travel patterns to ambient air quality</td>
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<td>Air-quality improvements due to selected change in travel patterns as result of improved level of transportation services</td>
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<td>Air-quality improvements due to selected change in travel patterns as result of improved level of transportation services (exogenous factors, improved efficiency of transportation vehicles)</td>
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<td>Noise level reductions due to selected actions</td>
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<td>Impact on surface water (groundwater) due to facility construction</td>
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<td>Impact on animal and/or plant life due to facility construction and/or transportation operations</td>
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<td>Activities (persons) affected by excessive noise levels</td>
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<td>Acres (areas) of sensitive land use affected</td>
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<td>Number of displacements (disruptions) to designated existing investment areas due to construction (operation) of a transportation facility (service)</td>
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<td>Percentage of designated investment areas within specified distance of a transit stop</td>
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<td>Number of displacements (disruptions) to designated existing investment areas due to construction (operation) of a transportation facility (service)</td>
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procedure is to be repeated for each of the summary measures in relating them to the specific policies.

Policy-Related Measures

The policy-related measures provide the means by which to assess directly the degree of adherence to regional policies without regard to whether or not any of the seven basic objectives are being attained. In some cases, the policy-related measures are identical to the objective-related measures. In other cases, two separate sets of performance measures are required. Which situation applies depends on whether or not the policy can be completely represented by the basic objectives.

As an example of the two kinds of situations, consider Metropolitan Council policies 1, 8, 10, and 23 (in order to better demonstrate the methodology used, this section focuses on some of the specific policies and not on the aggregate policy clusters):

1. Policy 1--The major transit and highway investments should be concentrated within the urban service area (as defined in the Development Framework chapter of the Metropolitan Development Guide).

2. Policy 8--Safety standards must be a major consideration in the planning, design, and maintenance of transportation facilities and services.

3. Policy 10--Discourage the use of automobiles in those areas where air quality is unacceptable if automobile emissions are a major contribution to the degradation of the air.

4. Policy 23--Equal emphasis should be placed on transit service and investment within subregional areas and to and within the metropolitan centers.

Policies 8 and 10 make explicit reference to two of the basic objectives. Policy 8 refers to the objective, "improve travel safety", and policy 10 refers to "promote environmental quality". Using the performance measures developed for these two objectives will provide an indication of how well these two policies are being achieved. Therefore, for these two policies the policy-related measures and the objective-related measures are identical.

For policies 1 and 23, however, the situation is different. While they can also be measured with respect to the basic objectives--namely, the objectives of "promote the effective use of existing investments" and to "promote positive economic impacts" (with the added objective to maintain accessibility and mobility for policy 23), a direct measurement of these policies requires performance measures that do not necessarily measure the attainment of the basic objectives. An example of a performance measure that can be used in the evaluation of each of these policies is the following performance measure for policy 1: local dollars appropriated (spent) on transportation investments within the urban service area in relation to the local dollars appropriated (spent) on transportation investments outside the urban service area.

The extent to which transportation investments are concentrated within the urban service area can be determined by the above measure. However, it is possible to evaluate adherence to this policy--namely, to concentrate transportation investments within the urban service area--without necessarily determining whether the policy is also promoting the effective use of existing investment or promoting positive economic impacts.

A similar situation is represented by the following performance measure for policy 23: dollars spent on intrasubregional transit in relation to dollars spent on transit service from that subregion to the metropolitan center. Once again, it can be seen that satisfying this policy does not necessarily guarantee that the basic objectives will simultaneously be satisfied. It is possible to provide an equal level of service and investment within subregions and to and within the metropolitan centers but not necessarily to satisfy the basic
objective of maintaining accessibility and mobility. A set of proposed policy-related performance measures has been developed for each of the 36 regional policies. In all, 161 policy-related performance measures were developed, of which 75 were more detailed versions of the objective-related performance measures. The 86 that were not related to the objectives can be summarized as follows: 17 are indicators of ridesharing activity and effectiveness, 16 are transit supply measures, 12 are measures of transit use, 10 are measures of vehicle occupancy, 7 are highway supply measures, 7 are measures of public funding priorities, 5 are measures of public transit cost, 5 are measures of effectiveness for demonstration projects, 4 are indicators of ridesharing activity and effectiveness, and 4 are indicators of the locations of transit-dependent populations.

As an example, the policy-related measures for the Metropolitan Council's regional policy 8 are presented below. Regional policy 8 states that "standards must be a major consideration in the planning, design, and maintenance of transportation facilities and services." The performance measures related to this policy are as follows:

1. Number of transit accidents per 1,000,000 revenue vehicle miles (route, etc.),
2. Number of automobile accidents per mile of facility (1,000,000 vehicle miles, intersections),
3. Number of transit passenger injuries (fatalities) per mile of facility (vehicle miles, intersections),
4. Number of automobile passenger injuries (fatalities) per mile of facility (1,000,000 vehicle miles, intersections), and
5. Number of accidents significantly attributable to dangerous operating conditions (structural problems of the facility, vehicle design, or inadequate facility or transit vehicle maintenance).

A full set of the policy-related performance measures can be obtained from either the Metropolitan Council or Cambridge Systematics.

OVERVIEW OF PERFORMANCE MEASURES

A set of 15 overview performance measures was developed to satisfy the last of the nine purposes stated earlier in this paper, namely "to provide a set of indicators of the state of transportation in the region". Either for 15 measures provide no direct indication of policy adherence, policy effectiveness, or objective attainment but do allow for comparison of the state of the region over time or comparison of the Twin Cities area with other regions. The overview measures, which are presented below, are for the most part restatements of either objective-related measures or specific policy-related measures (measure 12, which is not an objective or policy-related measure, is designed to reflect travel patterns that could influence the effectiveness of the transportation system):

1. Transportation expenditure (public) per capita;
2. Percentage of transportation expenditures made inside the MUSA;
3. Work-trip modal split;
4. Average trip length (by trip purpose);
5. Average vehicle occupancy (by trip purpose);
6. Accidents per million person miles of travel;
7. Percentage of population in the MUSA with access to the regional transit system;
8. Percentage of employment in the MUSA that is accessible by means of the regional transit system;
9. Percentage of households within a 30-min travel time from any part of a designated subregion to any other part of that subregion by transit and highway during off-peak periods for residents of that subregion;
10. Percentage of households within a 30-min travel time from any part of the MUSA to either metropolitan center by highway during off-peak periods for residents of the MUSA;
11. Percentage of households within a 45-min travel time from any part of the MUSA to either metropolitan center by public transit for residents of the MUSA;
12. Place of Residence
   Inside MUSA outside MUSA

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<tr>
<th>Place of Residence</th>
<th>Inside MUSA</th>
<th>Outside MUSA</th>
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<tbody>
<tr>
<td>Work</td>
<td>MUSA</td>
<td>MUSA</td>
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<tr>
<td>Outside MUSA</td>
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13. Annual transportation-related energy consumption (by fuel type) per capita;
14. Comparison of the estimated cost of a single-occupant automobile trip with the cost of a transit trip, when each is of average trip length; and
15. Number of locations in which federal air quality standards are not met.

These overview measures were developed for informational purposes and not for the purpose of policy analysis as were the other measures.

APPLICATION OF PERFORMANCE MEASURES IN EVALUATION OF REGIONAL POLICIES

An important step in the development of performance measures is the operationalizing of the measures. By this, we mean the process by which a performance measure is estimated and used in evaluation. Operationalization includes the detailed specification of a performance measure to relate it to the situation being evaluated, determination of the data necessary for evaluation, and the appropriate data-collection techniques.

In operationalizing the performance measures, each is analyzed to determine the ease with which it can be measured. Depending on this assessment, the measure may be respecified to improve its measurability or to take advantage of existing data if this will not significantly compromise the intent of the measure. For those measures for which data do not exist and a new data-collection effort is not considered to be feasible, the measure is either eliminated or assigned a low priority.

Once the measurability criterion has been considered, each performance measure is analyzed with respect to eight other criteria that must be satisfied in developing a final set of performance measures. These criteria are cost, pertinence, clarity, sensitivity and responsiveness, appropriate level of detail and aggregation, nonsensitivity to exogenous factors, comprehensiveness, and discrimination between influences.

It should be noted that the set of preliminary measures developed to date has not yet been reviewed with respect to the criteria listed above. This screening will occur during the phase of this study that is currently in progress.

A final step in the operationalizing of performance measures is the specification of data storage and retrieval systems that facilitate performance...
The performance measure study for the Metropolitan Council of the Twin Cities area has illustrated the usefulness of multimodal performance measures with a regional planning orientation. The measures developed for the Metropolitan Council include many of the more traditional highway and transit-supply-oriented measures that have been applied in performance reviews throughout the country. However, the highlight of this study is that it has also produced performance measures that reach beyond the supply characteristics to relate the supply of transportation and the attainment of planning objectives.

SUMMARY

Three types of measures have been developed for the Metropolitan Council to meet their many needs: The first type was designed to assess attainment of regional planning objectives, the second was designed to evaluate performance with respect to specific policies, and the third was designed to provide an overall picture of the state of transportation in the region. In all, roughly 200 measures were necessary to satisfy the needs implied by the many types of applications that the Metropolitan Council can make of the measures in performance review: each type of use requires a different type of measure.

Although a large number of performance measures were presented to the Metropolitan Council, a methodology for their use was also developed that results in a practical, straightforward, and comprehensible program for performance review. The methodology ensures that there is a performance measure appropriate to each need.

ACKNOWLEDGMENT

We wish to recognize the support and assistance provided by the Metropolitan Council of the Twin Cities area and the partial funding provided by the Urban Mass Transportation Administration, U.S. Department of Transportation. In particular, we wish to thank the Metropolitan Council Performance Measures Task Force and the transportation staff.

Further helpful insights were provided by Marvin L. Manheim of Cambridge Systematics, Inc., G.J. (Pete) Fielding of the Institute for Transportation Studies at the University of California at Irvine, and Earl Ruiter of Cambridge Systematics, Inc. We are grateful for those insights.

Our special thanks go to Carol Walb, Susan Billings, Patti Kinnear, and Sarah Sly for their contributions in the preparation of this paper and to James Wojno for his role in the preparation of the graphical material.

Although we acknowledge the contributions of those mentioned above, the views expressed in this paper are ours and do not necessarily reflect the views of the above-mentioned persons, the Metropolitan Council, or the U.S. Department of Transportation.

REFERENCE


Publication of this paper sponsored by Committee on Transportation Systems Design.