Quantitative Approaches for Project Prioritization: A Puget Sound Case Study

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ABSTRACT

Transportation projects in major metropolitan regions can vary widely in the types of benefits they provide and in the scales of those benefits. Travel forecasting models and related procedures can provide reasonable estimates of those benefits and many of the benefits can be distilled into equivalent dollar benefits using consumer surplus or other valuation approaches. In theory, those methods could be used to prioritize projects for funding consideration. However, simply choosing projects that provide the greatest net economic benefits may not result in a mix of projects that most effectively accomplishes broad regional goals. This paper describes an approach to project prioritization that was developed to support stakeholder-based weighting of multiple goals and, for each goal, multiple measures. The approach uses the analytic hierarchy approach to develop weights for each goal and a conjoint-based method to estimate stakeholder weights for each measure.

The approach was applied as part of the Puget Sound Regional Council's Transportation 2040 process and achieves the goals in VISION 2040—the long range land use plan. Weighting exercises were conducted with two stakeholder groups and the results were applied to a set of proposed ferry, rail, highway and local road projects. This paper describes the details of this case study and provides observations and conclusions from the work. The principal findings of the experiment were that statistically robust modeling conducted in real-time during planning committee meetings can improve the transparency, equity, and collaboration of the project prioritization process.

1. INTRODUCTION

The Puget Sound Regional Council (PSRC) is the principal forum for regional decision-making in the central Puget Sound region of Washington State. PSRC works with local government, business and citizens to build a common vision for the region's future, expressed through three connected major activities: VISION 2040, the region's growth strategy; Transportation 2040, the region's long-range transportation plan; and Prosperity Partnership, which develops and advances the region's economic strategy. PSRC has the momentum of its stakeholders (through public input, technical advisory committees and policy boards) to move towards greater regional sustainability with the implementation of the Transportation 2040 Plan.

The Puget Sound Regional Council's General Assembly adopted Transportation 2040 on May 20, 2010. Transportation 2040 is an action plan for transportation in the central Puget Sound region for the next 30 years. During that time, the region is expected to grow by roughly 1.5 million people and support more than 1.2 million new jobs. All of these new people and jobs are expected to boost demand for travel within and through the region by about 40 percent.

Evaluation Criteria

The development of Transportation 2040 involved a formal analysis of a range of plan alternatives. This analysis of alternatives integrated quantitative analysis (land use and travel modeling) with qualitative assessment (policy analysis). VISION 2040, the region's growth strategy, was the organizing framework for the evaluation; its goals, objectives and policies guided the development of formal evaluation measures. These measures fell under the following seven criteria categories:

- Mobility
- Finance
- Growth Management (the objectives of the Regional Growth Strategy)
- Economic Prosperity (the objectives of the Regional Economic Strategy).
- Environmental Stewardship
- Quality of Life
- Equity

Early in the development of the evaluation criteria numerous technical and policy committees in the region were identified as instrumental in providing feedback on the sufficiency of the criteria and the approach. A key message from many of the groups was that quantitative measures are not sufficient, and it is necessary to provide qualitative measures to adequately address areas of policy interest. The evaluation criteria were seen as a way to measure progress toward achieving VISION 2040, and were developed to address the overarching goals of the transportation planning process. Individual metrics were developed to quantify different aspects of each evaluation criteria.

Many of the criteria measures were estimated in monetary values so they could be included in a benefit-cost result. Other criteria measures were reported with measures indicating direction and scale of change. The advantages of the benefit-cost approach are that both benefits and costs can be combined to assess the potential economic consequences of a particular transportation alternative. The disadvantage is that non-monetizable measures, such as growth management or economic prosperity, cannot be directly integrated. The full set of evaluation criteria recognizes the advantages of the benefit-cost method but combines this with other quantitative and qualitative measures to provide a more comprehensive assessment of each alternative.

Balancing Multiple Priorities

PSRC has now expanded on this approach by developing a formal process through which criteria measured on independent scales can be integrated more completely. This is a standard multiple criteria problem with a range of possible remedies, all of which involve the development of some kind of policy weights, recognizing the need to balance multiple priorities.

Following adoption of the plan, a process for prioritizing projects included in the plan to ensure support for implementation of VISION 2040 was developed. As prescribed by PSRC's Executive Board, any process that is developed to assign priorities to actions and investments must be done in an open, balanced, collaborative, and equitable manner.

As the region implements Transportation 2040, PSRC is committed to developing and applying new administrative procedures based on adopted regional policy to:

- Admit future actions, projects, and investments to the plan and determine their status upon admission
- Remove existing actions and investments from the plan if appropriate
- Change the status of actions and investments within the plan
- Assign priorities to actions and investments.

The procedures developed should utilize a common evaluation framework where possible, and should explicitly assess key VISION 2040 policy areas including:

- Support for the regional growth strategy, including focusing growth in regionally designated centers inside the Urban Growth Area
- Reducing greenhouse gases
- Reducing vehicle miles traveled
- Addressing freight mobility
- Providing sustainable funding
- Supporting equity and environmental justice
- Reducing impacts on Puget Sound water quality
- Addressing congestion and mobility
- Promoting economic activity and employment growth
- Achieving a jobs-housing balance

The evaluation framework will be applied to the long range transportation planning and may also influence the future evaluation of projects for federal transportation improvement program (TIP) funds, monitoring the transportation 2040 plan, and monitoring of the transportation system.

2. BACKGROUND

Regional Vision

The Transportation 2040 plan (*1*), and the transportation projects within it, do not operate in isolation, but rather are guided by the region's long range land use plan VISION 2040. VISION 2040 is the regional strategy for accommodating population and employment growth by 2040 (*2*). The concept of *people, prosperity and planet* is a central component in the strategy addressing sustainability and requiring consideration of a triple-bottom-line, addressing economic, environmental and equity issues.

The regional growth strategy contained within VISION 2040 explicitly allocates population and employment by six regional geographies (metropolitan, core, large and small cities, unincorporated urban areas and rural areas). Each regional geography is intended to serve a unique role in the region in order to protect natural and resource lands, to improve air and water quality, to reduce congestion and to ensure the efficient provision of services. To that end, the growth strategy includes 27 designated regional growth centers in order to further concentrate population and employment as well as to protect strategic industrial areas. The regional growth strategy is complimented by an environmental framework, six policy sections, and implementation actions in order to promote the well-being of people and communities, economic vitality, and a healthy environment.

Travel Model and Economic Valuation Approach

The starting point for any analysis of transportation investments must involve a systematic means of estimating the project's effects on travel demand. The PSRC Benefit-Cost Analysis (BCA) tool (*3*) was designed to make use of comprehensive databanks produced by the PSRC regional travel demand forecasting models. A project is characterized in the travel models' transportation networks for one or more analysis years, the models are run for both a build case (a network where the project has been implemented) and a base case (a network where the project has not been implemented). The PSRC BCA tool generates estimates of user benefits (travel time savings, travel reliability benefits, vehicle operating cost savings, accident risk reduction benefits, and vehicle emission reduction savings) directly from mathematical transformations (consumer surplus calculations) of the differences between the build and base cases.

The Puget Sound Regional Council (PSRC) has developed a set of procedures and methods for project and program evaluation that fall generally into the category of transportation benefit-cost analysis. The purpose of these methods is to be able to produce information about project or program performance, relative to a baseline set of conditions where the project or program has not been implemented. Benefit-cost methods produce information about the relative magnitude of benefits and costs that accrue (over time) to society as a result of any given action.

An important element in project and program evaluation is the identification of two alternate states of the world; one state of the world in which the project, program or policy has been implemented, and one state of the world where the project, program or policy has not been implemented. In all other respects these states of the world resemble each other. The objective is to isolate the consequences of the investments or change in policy. In this respect, there is a natural affinity between prospective benefit-cost analysis and models of systems change, like those employed for transportation planning. In a model framework it is possible to selectively represent a change in policy or investment while holding everything else constant.

The basic steps in the benefit-cost analysis process *(3)* are as follows:

1. Define the Project Alternative and the Base Case
2. Determine the level of detail required
3. Develop basic user cost factors (values of time, vehicle unit operating costs, accident rate and cost parameters, vehicle emission rate and cost parameters, etc.)
4. Select economic factors (discount rate, analysis period, evaluation date, inflation rates, etc.)
5. Obtain traffic performance data (for Project Alternative and Base Case) for explicitly modeled periods
6. Measure user costs (for Project Alternative and Base Case) for affected link(s) or corridor(s)
7. Calculate user benefits
8. Extrapolate/interpolate benefits to all project years (unless all time periods are explicitly modeled)
9. Determine present value of benefits, costs

Transportation investments provide benefits directly to users in the form of travel time savings, and reductions in other costs of travel. When the perceived costs of a trip are reduced consumer surplus increases. As travel times are reduced between any origin and destination, users already making this trip enjoy lower costs while new users (for whom the willingness to pay was less than the old cost of the trip) now take advantage of a travel opportunity that was not attractive to them before. This leads to a simple approach to calculating the benefits of the improvement: subtract the consumer surplus without the improvement from the consumer surplus with the improvement. To do so, we need to know only two things:

- The willingness-to-pay (demand) relationship that is involved, and
- The effect of the improvement on the users' perception of his/her cost of travel.

We don't have to know very much about the willingness-to-pay relationship to implement this procedure. All we need to know is the effect on additional travel of a change in travel costs. And the basic user benefit calculation can be made more detailed to recognize the major sources of user benefits: the savings in travel time, operating cost, reliability, and accident costs, and the consumer surplus that such savings generates *(4)*. This user benefit calculation is formula 2-5 from the AASHTO User Benefits manual. Unreimbursed accident costs are included here because they are user costs and reimbursed costs are paid by a third party so not included as user costs.

$$B_{chst} = \Delta U_{chst}\left(\frac{V_{chst,0} + V_{chst,1}}{2}\right)L = (\Delta H_{chst} + \Delta OC_{chst} + \Delta AC_{chst})\left(\frac{V_{chst,0} + V_{chst,1}}{2}\right)L_s$$

where:

B_{chst} = user benefit to vehicle or user class c, at travel hour h, on link s, in project year, t

ΔU = change in per - VMT user cost

$\Delta H = H_0 - H_1$ = change in per – VMT (or per - user) valuer of travel time (without minus with)

$\Delta OC = \Delta OC_0 - \Delta OC_1$ = change in per - VMT (or per - user) operating costs (without minus with)

$\Delta AC = \Delta AC_0 - \Delta AC_1$ = change in per - VMT (or per - user) unreimbursed accident costs (without minus with)

V_0 = vehicles (or users) of class c in hour h without the improvement

V_1 = vehicles (or users) of class c in hour h with the improvement

L = the segment or corridor length, in miles

The user benefit calculation also incorporates induced traffic demand by incorporating traffic volumes with and without the project. This induced demand includes changes in trip making derived from an activity-based model for trip generation and subsequent changes in trip distribution, mode choice and time of day models, all of which can contribute to induced demand on the roadway system. Although the PSRC modeling system is an integrated land use and travel demand forecasting model, the land use model was not run for the individual projects tested here because the land use effects were expected to be small and would not impact user benefits significantly.

It is important to note that projects have more than one type of user. As such the PSRC regional travel demand models and the BCA tool represent multiple user classes. These user classes exhibit different values of time, or choose different modes of use, or are influenced by the improvement in a different way. In addition, the user benefits will vary with the time period of the travel day being modeled, the project year, and the segment or corridor affected by the project improvement. The proliferation of the number of user classes, facility segments, project years and travel times makes the accurate measurement of user benefits something that must be done using an organized accounting of all of the calculations, such as that which is implemented in the PSRC BCA tool.

The formula, above, is a basic building block of user benefit analysis; and is applicable to all user benefit calculations that involve changes in perceived user cost, and which play out over various origins and destinations or the various segments of travel corridors. It is general enough to be applied to analysis that is done by corridor, by road segment, by vehicle class or by user class

In particular, the following project or program impacts lend themselves to monetization and are included in the PSRC BCA tool (further details on these costs and benefits can be found at *(3)):*

- Travel time savings.
- Accident cost savings.
- Vehicle operating and ownership cost savings.
- Travel time un-reliability savings.
- Facility operating cost impacts.
- Facility capital cost impacts.

- Vehicle emissions costs.

The PSRC commissioned the development of custom benefit-cost accounting software from the consulting firm ECONorthwest. The software developed by ECONorthwest makes use of standard data available in specially prepared travel model databanks from the regional travel demand model software, EMME3. The databanks contain various trip cost, time, vehicle class and time of day information aggregated at either the origin-destination pair or links in the model network. This data is extracted and processed in a manner that permits consumer surplus and environmental benefit accounting when one model run is compared directly with another model run that is characterized as the base case scenario. The benefits-cost analysis tool consists of a number of software elements written in the Python programming language. Data is processed and stored as schema in a Postgres relational database. Results are then compiled through a web-based (Django) user interface, with user programmable input parameters, and then tabulated in .csv output files that can be opened directly with standard spreadsheet software.

Benefit-cost analysis can be used to guide decisions about the relative ranking, or prioritization, of numerous investment options, or can be used to determine the economic usefulness of making any given investments in the first place. Like any analysis technique, benefit-cost analysis is subject to numerous constraints, from the accuracy of the data used in the estimation process, to uncertainty about values to be employed in the analysis (either due to incomplete science or philosophical and ethical disputes). The purpose of analysis is not to resolve all such disputes, or eliminate uncertainty (and thus the need for judgment), but rather to provide a rich body of information assembled in a disciplined manner that can aid decision makers when faced with difficult investment or policy decisions. As a result, benefit-cost analysis can seldom be the sole means of assessing the usefulness of a project, program or policy. Such analysis can however significantly aid the evaluation process by integrating across multiple objectives and applying discipline to the accounting of benefits within a complex setting. And when combined with analysis of other policy objectives (for example those related to how benefits are distributed across members of society), benefit-cost analysis becomes an invaluable tool for project and program evaluation and the development of plans for investment.

PSRC Committee Direction

PSRC's work on the Transportation 2040 project prioritization is guided by the Transportation Policy Board (TPB), which includes representatives of the PSRC's member jurisdictions, and regional business, labor, civic and environmental groups. The TPB has convened a new subcommittee, the T2040 Prioritization Working Group to devote particular attention to transportation project prioritization. The Working Group has met on a monthly basis and includes member of the TPB as well as members from the Growth Management Policy Board and the Regional Staff Committee.

The Regional Staff Committee (RSC) includes high-level staff from PSRC's member jurisdictions as well as the region's transit agencies. PSRC staff has worked collaboratively with the RSC on project prioritization in order to develop the criteria use in the evaluation as well as to discuss policy issues related to prioritization. Once issues are addressed through the RSC, they are brought to the Working Group. Both the RSC and the Working Group have been actively engaged with the development of the evaluation framework, assisting with the development of five overarching outcomes (goals) and 17 qualitative and quantitative measures.

3. APPROACHES FOR PRIORITIZATION

Methods for Weighting Goals and Outcomes

A number of different approaches have been used to support transportation project prioritization. Benefit-cost analysis is appropriate when all benefits can be collapsed into a single monetary measure and when that measure itself is a reasonable reflection of program goals. However, it is commonly the case that benefits cannot reasonably be collapsed into a single monetary measure and, instead, a multiple criteria decision making (MCDM) process is required. This type of process can be used with a set of weights that are applied to each of the criteria. The weights can be asserted or derived from a process that involves multiple decision-makers or stakeholders.

The Analytic Hierarchy Process (AHP) has been widely used to develop criteria weights in many types of such applications, including a number of transportation applications (~~4~~*5*, ~~5~~*6*, ~~6~~*7*). AHP provides a way for stakeholders to express their relative priorities across multiple goals using a set of pairwise comparisons of the goals (~~7~~*8*). The judgments made in these comparisons can then be used to derive the weights that stakeholders implicitly apply to each goal. This application involved five goals -- for this study the term "outcomes" was used in place of "goals"– and so the AHP exercise was structured to consist of all ten possible pairwise comparisons of these goals.

Methods for Evaluating Trade-offs Among Measures

While AHP is very useful in developing weights for multiple goals, it is more limited in its ability to determine the ways in which quantitative performance measures satisfy those goals. Past studies have used the Technique for Ordered Preference by Similarity to Ideal Solution (TOPSIS) to apply weights to normalized project performance measures and used the resulting metrics to rank order those projects (~~8~~*9*, ~~9~~*10*). However, in many cases, achievement of a general goal can be gauged by several different performance measures and so there is also a need to determine the relative importance of each of those measures in relation to a particular goal. In addition, the importance of a particular measure might vary across the range of performance of projects along that measure and so this variation in importance across the scale might not be accurately represented by an assumption of linearity.

There are several ways to determine the relative importance of different performance measures across the range of those measures. A conjoint-based approach was developed for this application. Conjoint methods have also been used widely to support transportation applications and, more specifically, travel choice modeling (~~10~~*11*, ~~11~~*12*), but the application here was designed specially to complement an AHP weighting exercise. For each goal, conjoint exercises were structured to elicit information about the relative importance of each of the performance measures in achieving that goal. The number of conjoint exercises required for each goal depends on the number of performance measures being tested for that goal as well as the number of levels to be tested. Each measure was defined by 3 levels of change (based on the initial set of projects) and required a minimum of 9 questions for each goal (with a range of 2-4 performance measures) and 12 questions for the mobility goal with 5 performance measures.

One alternative to the hybrid AHP/conjoint method that was considered for this application was to create conjoint exercises in which all performance measures were considered together. This would allow estimation of weights for all performance measures simultaneously and implicit weights for the goals, avoiding the need for a separate AHP exercise. However, the resulting conjoint exercise would need to be quite large to allow estimation of all effects together from relatively small stakeholder respondent groups. In addition, the stakeholder groups preferred the more direct and transparent AHP approach in which they could directly indicate their relative preferences among alternative goals. There is a tradeoff in terms of the application between the user-friendly hierarchical (AHP) approach and the ability to weight more measures with fewer questions in the conjoint approach. As a result, the hybrid AHP/conjoint method was selected to take advantage of the easy, transparent AHP approach and to reduce respondent burden with the conjoint method.

4. CASE STUDY STRUCTURE

The project prioritization process requires consensus on the goals and measures used to evaluate projects prior to conducting the experiment. This process to develop the goals and measures is similar to current quantitative or qualitative assessments of projects across the country, but is possibly more comprehensively and consistently applied across all projects so that all measures and goals apply to all projects. This requires measures that can be interpreted across modes and for different types of projects.

The Outcomes

Early on, PSRC committees determined that evaluating "outcomes" was preferred to evaluating "goals" since it was more specifically related to the preferred results rather than stated intentions. The outcomes were developed to identify what aspects of project evaluation were most important relative to the VISION 2040 goals. There were five outcomes identified by the PSRC committees:

- **Prosperous Economy:** whether the project encourages growth in employment and improves goods movement.
- **Mobility:** whether the project improves accessibility, efficiency and reliability of the regional transportation system and whether the project provides more travel choices through modal alternatives or modal connections.
- **Community Character:** whether the project is within or serves an established regional growth center, whether the project supports active living and personal health, and whether the project contributes to place-making.
- **Social Responsibility and Equity:** whether the project offers opportunity through accessibility to all residents equitably
- **Sustainable Environment:** whether a project reduces or mitigates air and water quality and promotes healthy habits.

These outcomes were developed to specifically address the goals of the VISION 2040 process for livable communities, prosperous economy, social responsibility and a sustainable environment. The livable communities' goal is represented by both the mobility and community character outcomes.

The Measures

There are 17 measures to evaluate the five outcomes, as shown in Figure 1. These measures include both qualitative and quantitative measures. Measures are designed to comprehensively represent the five outcomes, but in some cases the measures are proxies for the outcome, given known limitations in the currently available data. For example, fostering economic growth is based on the dollar value of user benefits for concentrations of economic development cluster employment and modal connections are based on whether there is an improvement in walk and bike access to transit.

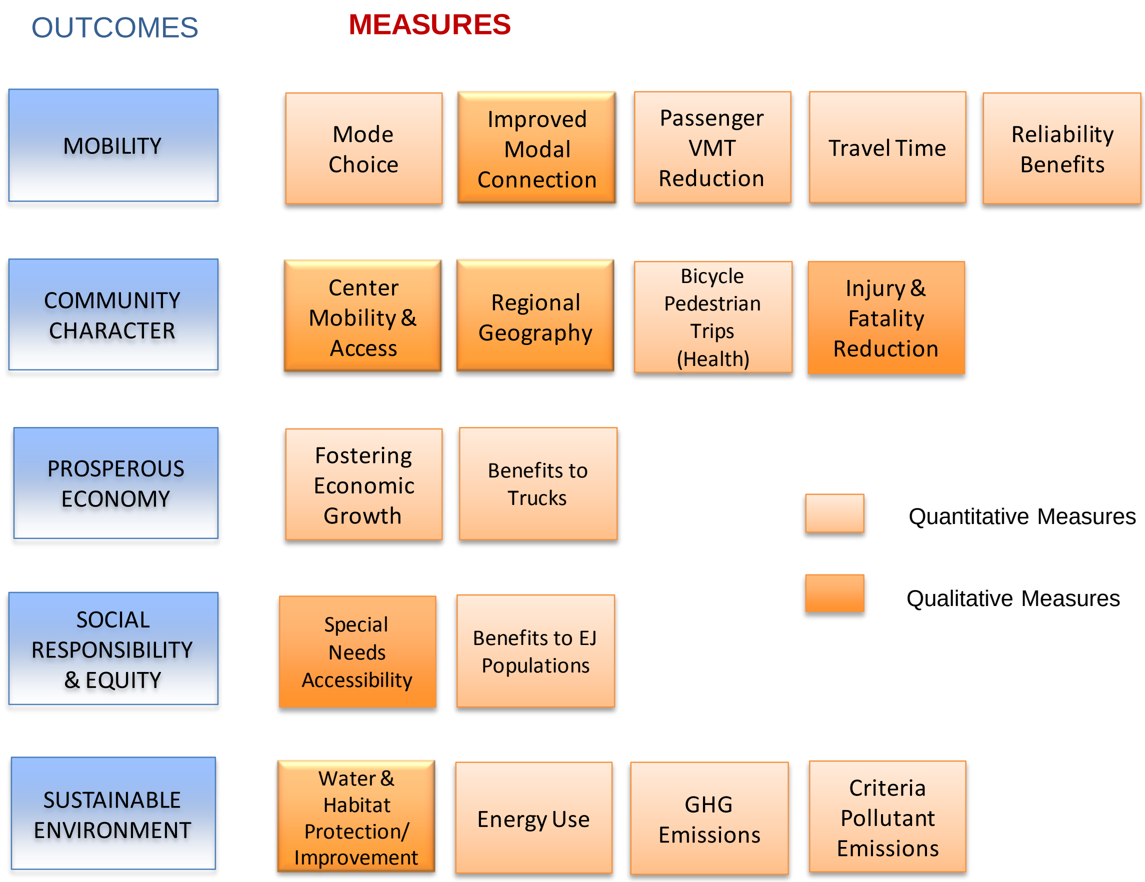

Figure 1. Prioritization Outcomes and Performance Measures

All of the measures considered in these experiments were benefits (either positive or negative) of a transportation investment. Cost was considered as a separate element and applied as a post-screen, meaning that the project prioritization provided an initial ranking of projects based on project benefits and then a subsequent ranking of projects based on project benefits compared to costs. The concept was to rank projects based primarily on their benefits and then to consider cost as a reality check. The benefit and cost comparisons do not equate to benefit-cost ratios since the benefits are unit-less, having been derived from a set of measures with varied units, and combined using the weights determined from the surveys.

Project descriptions

Eight sample projects were evaluated for the prioritization exercise to provide a better understanding of the weighting process. These eight projects were selected to provide a wide range of types and modes:

- **Transit Rail Extension –** extend light rail transit (LRT) to a metropolitan city
- **Transit Bus Service Expansion –** add a bus rapid transit (BRT) route
- **Transit Ferry New Route –** add a passenger only ferry route to existing ferry terminals
- **Interstate Widening –** add general purpose and high occupancy vehicle lanes in each direction on an interstate route

- **State Route Widening –** add a general purpose lane in one direction on a state route
- **Arterial Widening –** add a general purpose lane on a major arterial in each direction
- **Traffic System Management –** convert shoulders for use in peak periods in the peak direction of travel as an additional lane
- **Travel Demand Management** – expansion of the existing vanpool program

Additional non-motorized, paratransit, and intelligent transportation system projects were considered in a second evaluation, but are not covered in this paper.

Each project was scored for the 6 qualitative measures and the travel demand forecasting model and benefit-cost analysis tools were employed to produce values for each project compared to the long range transportation plan baseline scenario. These values and scores were developed prior to the meetings, where the weighting exercise was carried out,so that the project prioritization process could be implemented during the meetings.

Structure and administration of the exercise

The experiments were conducted for two PSRC committees (Regional Staff Committee and the Prioritization Working Group) and an initial beta test with PSRC staff was conducted prior to the meetings. Minor adjustments in the descriptions of the measures improved the ability of committee members to understand the measures and vote accordingly.

Each member of the committee was provided with a mobile device (or used their own) to answer a series of 48 questions to define their preferences for each measure (using choice-based conjoint) and another 10 questions to define their preferences for outcomes (using AHP). Each set of measures were described to committee members and discussed prior to the set of questions for those measures. Model estimation was conducted after each set of measures were completed so that modeling results could be presented a few minutes after the completion of the surveys. Questions and background materials on the outcomes, measures and projects were provided to committee members for reference during the survey, since this is too much data to remember.

The surveys were designed as web-based surveys so that respondents could participate on mobile devices during a meeting or on the internet remotely before, during or after the meeting. The purpose of conducting the analysis and providing results during a single meeting was to ensure transparency and encourage discussion of the results in the context of the overall process. Subsequent surveys may be conducted on-line before a meeting, since the respondents are now well informed about the process, the measures, and the outcomes. The length of the survey (about an hour), the preliminary discussion of measures and outcomes over several meetings and the initial discussion of results during the meeting indicated the one can conduct the survey and discuss results in a single meeting, but that additional time to consider the results thoroughly would require more time.

5. CASE STUDY RESULTS

There were 3 sets of case study results, one for each of the three meetings where the experiments were conducted. The results presented in this paper focus on the third meeting (Prioritization Working Group).

Outcome weights

Outcomes were evaluated in overall importance (Figure 2) and to review the distribution of responses (Figure 3). Some participants felt that all outcomes should be equally important, but the results show that mobility and the economy were of higher importance than community character, a sustainable environment or social responsibility. There was some discussion that these may reflect the relatively weak economy and the need for accessibility to support the economy. These discussions confirmed the expectation that these outcome weights should be reconsidered on a regular basis to ensure that they are consistent with current planning goals.

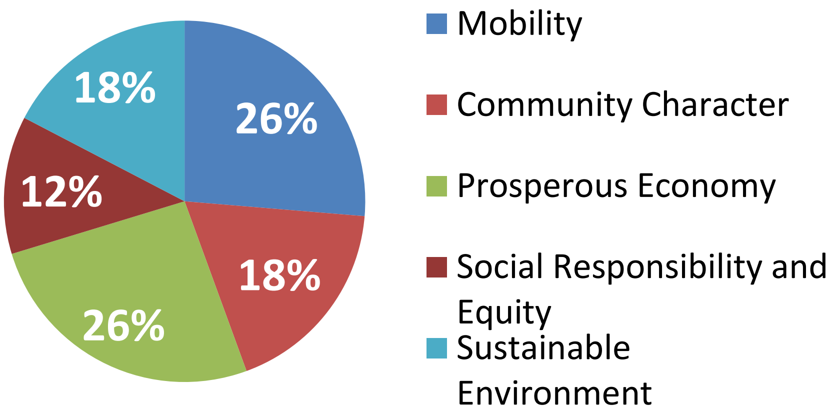

Figure 2. Importance of Outcomes

The distribution of outcome importance was a useful tool to demonstrate the varied responses for each outcome, as shown in Figure 3. This provided a range of responses to show whether the responses were similar (e.g. social responsibility and equity) or a wide range (e.g. prosperous economy). This demonstration of individual responses provided transparency in the results for decision-makers and allows for an understanding of the extent to which the outcome weights were developed by consensus.

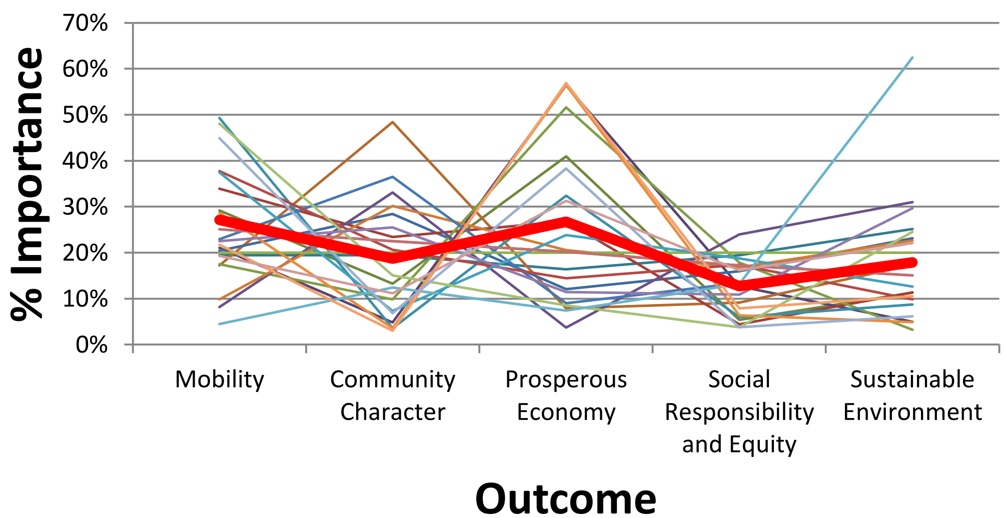

Figure 3. Distribution of Outcome

Measure weights

Weights were measured individually as a percent importance for each outcome as a result of the conjoint exercise for each outcome. In addition, individual measures were calculated as an overall percentage (Figure 4), given the set of projects being considered for this experiment. The weighting reported in Figure 4 could change for a different set of projects and is reported as an byproduct of the process, but the individual weights for each measure within an outcome will not change. Each measure is weighted by the outcome weight associated with that measure. As the number and type of project being prioritized, this set of importance for each measure may change slightly. Benefits to trucks is an important measure within the goal of a prosperous economy, which is also of high importance among the other outcomes, resulting in a high importance overall.

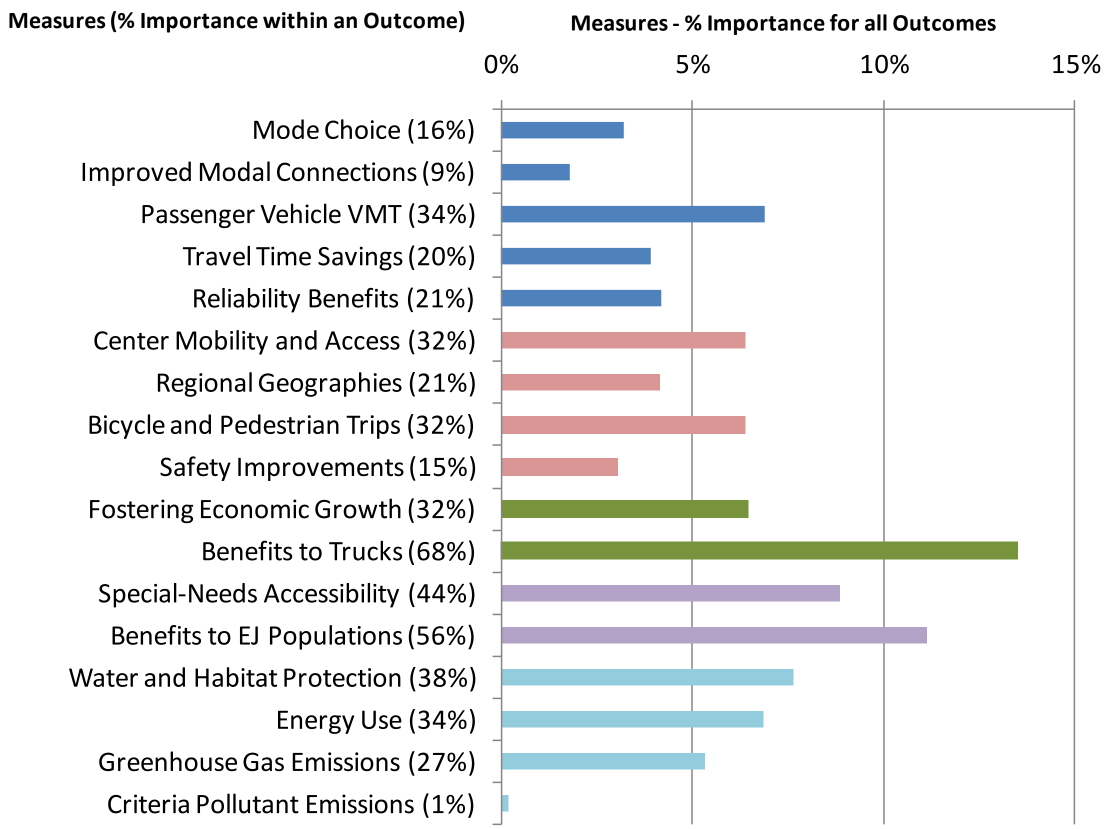

Figure 4. Overall Importance of Measures

Project Prioritization

Eight sample projects were prioritized using the preferences from the decision-makers in the AHP and choice-based conjoint analyses. These were actual projects from the long range plan but were anonymized for the purpose of the exercise to focus on the methods rather than the specific projects being evaluated. This initial prioritization was based solely on benefits and is called total project benefit scores. A subsequent post-screening prioritization was based on the project benefit scores divided by the annualized cost of the project (called Total Project Benefit to Cost Ratios), as shown in Figure 5. Figure 5 also includes a comparison to a more traditional benefit cost analysis (described earlier as the PSRC BCA tool), which represents only those performance measures that can be monetized (called Monetary Benefit to Cost Ratios). The results of each scoring process do not employ the same units so should be interpreted individually, but the results clearly show a different prioritization of the projects once cost is accounted for. A ranking of each scoring process (Table 1) demonstrates that the ranking is affected by the scoring method chosen and that the two methods which incorporate cost are more consistent than the remaining method including benefits without cost.

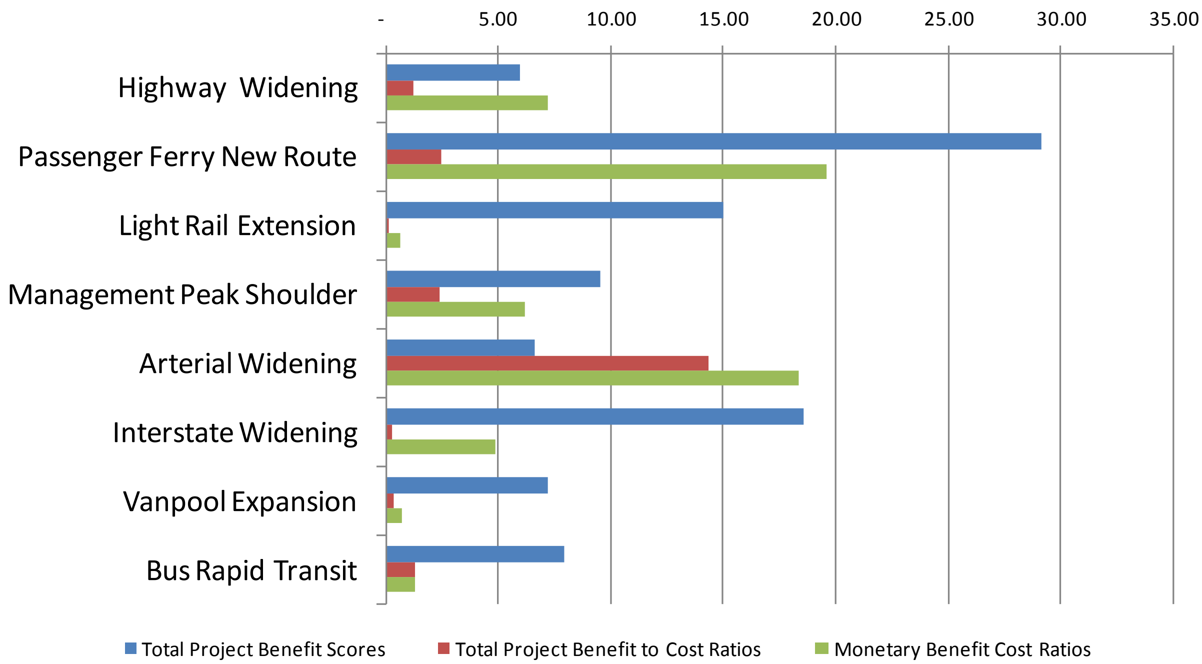

Figure 5. Project Scores - Before and After Cost Screening

Table 1. Comparison of Project Rank for each Scoring Method

	Total Benefit Score Rank	Total Benefit to Cost Ratio Rank	Montarary Benefit to Cost Ratio Rank
Passenger Ferry New Route	1	2	1
Interstate Widening	2	7	5
Light Rail Extension	3	8	8
Management Peak Shoulder	4	3	4
Bus Rapid Transit	5	4	6
Vanpool Expansion	6	6	7
Arterial Widening	7	1	2
Highway Widening	8	5	3

This review also highlights the importance of consideration of the assumptions for the baseline network, since all project benefits are produced as a change from the baseline. If the baseline network assumes a more limited set of improvements, then this may favor one or more projects in comparison. In this case, the baseline network was assumed to be consistent with assumptions in the long range transportation plan (only existing plus committed projects were included).

Observations from this application

The transparency and real-time aspects of the application were useful in promoting collaboration and bringing more statistically robust methods to the project prioritization process. The application clearly demonstrated a means to bring multi-criteria weighting for qualitative and quantitative measures into the process. The discussion among committee members during and after the experiment demonstrated the educational aspects of the process and also demonstrated that the complexity requires sufficient time before, during and after the process to achieve consensus. Subsequent experiments could be used to enhance the understanding further.

6. CONCLUSIONS AND RECOMMENDATIONS

The three applications of this approach provided different results and different insights on how to improve the approach for future applications. Each experiment demonstrated the usefulness of providing real-time statistical surveys of decision-makers to provide an assessment of goals and measures in determining the prioritization of individual projects. The discussion resulting from the experiment provided useful discourse on the importance of outcomes and measures and demonstrated differences of opinion among decision-makers.

The methods used in this approach are employed often in private sector market research and offer an opportunity for public sector use of the approach as input to decisions of multi-dimensional projects. The measures and outcomes used to evaluate these projects were determined to address all modes and all types of projects. While these methods are still in their infancy in terms of application, there is promise for allowing multimodal projects of different types (system management, demand management, capacity) to be evaluated on a level-playing field.

This approach shows promise as a screening tool for a wide variety of transportation projects and clearly demonstrates the importance of regional transportation goals in the process through surveys of decision-makers preferences. These preferences may change over time as new decision-makers are involved, as regional conditions change, and as regional goals are reconsidered. The approach was designed as an ongoing tool which could be re-deployed as needed to update the preferences of decision-makers. The web-based aspects of the tool provide a straight-forward deployment so that future experiments could be done by committee members on-line ahead of time or in real-time during the meeting as was done in these initial experiments.

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