management actively seeks public input on key elements of statewide planning, such as identification of issues, evaluation of policy options, and the development of transportation plans and programs. Also, because securing public funds is increasingly difficult, long-range plans are being financially constrained, and improvements that maximize the use of the existing system are being developed. Management also has a keen interest that planning efforts be focused toward program development and that central documents be developed that firmly link together financial resources with plans, programs, and letting schedules.

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Resort Transportation Improvements: Case of Little Cottonwood Canyon, Utah

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The objective of this study was to adopt a practical methodology for short-range transportation improvements that are fully responsive to the typical problem of recreational resources near an urban area. The methodology was applied to alleviate the transportation and related problems of ski resorts of Little Cottonwood Canyon of Utah. Specific evaluation data related to the canyon; however, the breadth of the system considered, the parameters developed, and the decision-making process suggested were structured so that the concept could be adopted as a consistent planning tool to resolve problems in similar recreation resorts. Emphasis was placed on simplicity and practicality of the developed methodology as well as on maximum accessibility and minimum negative environmental impacts. A specific park-and-ride bus transit system has been recommended for the study resort on the basis of economic factors and community responses. Application of the suggested methodology stressed intangible factors as well as strictly monetary factors.

The demand for leisure activities has caused serious transportation and related environmental problems at many recreation resorts. Obviously, the traditional dependence in the United States on private vehicles for recreation access has been a major contributor to these problems. Due to the recent energy shortage and high road construction cost, we must concentrate on more than just improvements to the existing highway system. In order to maintain a high level of recreational participation and enjoyment and also attain broader local and national goals (energy conservation, environmental improvements, equity for transit dependents, and preservation of natural aesthetics), transportation and recreation planners must now investigate a wide range of innovative transit systems to improve the accessibility of recreational resources.

As an example, Little Cottonwood Canyon, southeast of Salt Lake City, Utah, is the setting for excellent skiing activities. Its proximity to the major transportation facilities of the Salt Lake Metropolitan Area (SLMA) affords this canyon an opportunity to be a major ski resort complex on a local and national basis. In recognition of this potential, private developers have independently undertaken the construction of major resort facilities at the canyon. However, development of ski resorts (Alta and Snowbird) in the canyon has progressed with little coordination or consideration of existing transportation facilities. The only access road to the canyon (UT-210) is a narrow, winding, two-lane highway, which traverses rather steep grades over most of its length. The yearly increase in the number of private automobiles that use the access road often exceeds the road design capacity, and thus restricts the road in efficient and safe handling of traffic. Furthermore, the transportation problem is intensified by a shortage of parking space and the extreme peaks of weekend visitors.

In addition to the problems that traffic volumes create for highway users, they also have serious negative environmental impact on the canyon. The vehicles that use the canyon road produce air, noise, and water pollution. Specifically, water pollution may render the canyon water unsuitable for traditional water treatment in the near future; the canyon now provides approximately one-fifth of the water supply for the SLMA (1).

STUDY OBJECTIVE AND SCOPE

The basic objective of this study was to use a developed methodology to solve existing and potential transportation and related problems of Little Cottonwood Canyon. The methodological framework for this resort transportation improvement study was intended to be applicable, in general, to public decisions constrained by financial, social, economic, political, and environmental factors and situations in which the decision has to stress intangible, not strictly monetary, factors. Therefore, the study of Little Cottonwood Canyon was designed to be a prototype for development of a consistent planning tool to be used in resolution of problems in similar recreation resorts.

A bus system can be implemented quickly and without major capital investment, and thus can serve as an immediate alternative; therefore, determination was made as to the acceptability of a park-and-ride bus transit system. Economic factors and community responses were considered in this study. Such a transit system would improve canyon accessibility and also maintain environmental quality and conserve fuel energy and natural aesthetic qualities. The selection of transportation improvement alternatives required a clear understanding of the attitudes of all interested parties.

METHOD OF APPROACH

The following general procedure was employed in this study:

1. Establishment of goals and objectives—Great emphasis was placed on the establishment of transportation goals and objectives that adequately represent the values of the community. Only through the use of representative goals and objectives can a transportation plan be developed to successfully meet the needs of the community.
2. Inventory of bus transit potential—A procedure was developed to analyze the existing transportation characteristics and to determine travel demands, both for now and for the future. Included were preferred mode of travel and time of travel. Maximum use was made of existing data sources.
3. Analysis of desires and definition of potential service—Estimates were made of quantity and location of existing and future travel desires that might be attracted to the proposed bus transit system for different levels of service. Also, from the inventory data and subsequent analyses, current and future travel desires were ranked in order of ability to be served by bus transit.
4. Formulation and evaluation of alternative bus system—Based on the analysis of service potentials, several alternative bus transit concepts were delineated. Each alternative concept was critiqued as to general benefit/cost and community response in terms of economic benefit, level of service, environmental impact, financial considerations, and political acceptability.
5. Selection of an alternative for implementation—The final determination of an alternative bus system was based on the recommendations and analyses previously completed.

In this study, benefit/cost analysis and a rating scheme were applied to assist the decision-making body in identification of a preferred choice from all possible alternatives. The suggested methodology is considered a practical way to assess the desirability of alternatives by which the enumeration and evaluation of total cost-effectiveness are implied.

Establishment of Goals and Objectives

The goals of this study can be expressed in terms of how well the transportation facilities meet the travel demands and the environmental quality standards and also which of the alternative systems that is capable of servicing the demand does so at the least annual transportation costs. The goals of transportation agencies may at some points be in conflict with the goals of certain nonusers, whose goals are not met or ill served by the transportation improvement.

Specification of Relevant Alternatives

Seven different alternatives were considered:

1. Exclusive use of large buses (40 passengers) that originate from five park-and-ride terminals at specified locations in the SLMA and terminate in the ski resorts of the canyon,
2. Exclusive use of large buses that originate in the mouth of the canyon and terminate in the ski resorts (a large park-and-ride facility will be provided at the mouth of the canyon),
3. Exclusive use of small shuttle buses (14 passengers) that originate in the five park-and-ride facilities in the SLMA and terminate in the ski resorts,
4. Exclusive use of small shuttle buses that originate from the mouth of the canyon and terminate in the ski resorts (a large park-and-ride terminal will be needed at the mouth of the canyon),
5. Combined use of small shuttle buses and large buses in such a way that both vehicles will originate from the five designated park-and-ride facilities in the SLMA and terminate in the ski resorts (in this system large buses will be used during the peak demand periods, and small shuttle buses will be used primarily during the off-peak periods),
6. Combined use of small shuttle buses and large buses in such a way that both vehicles will be used for transport service between the mouth of the canyon and the ski resorts based on the demand fluctuation, and
7. Use of the current system (do-nothing alternative) (this alternative is considered for comparison).

Both small and large buses must be specially designed to provide ample space for carrying ski equipment. Alternatives 1, 3, and 5 require five park-and-ride facilities to be built at selected locations in the SLMA. The locations of these terminals were selected on the basis of population density, availability and cost of land, and equity of accessible service to all users in the SLMA. After visitors have parked their automobiles in these parking facilities, they will be carried by bus to the canyon ski resorts and back. For all proposed alternative bus systems, the area of ski resorts is assumed to be an automobile-restricted zone; however, canyon residents, road maintenance crews, and service personnel are allowed to drive to and from the canyon at all times.

COST ESTIMATION

The costs considered in this study are the direct costs of the transportation facilities and equipment plus the indirect costs of the transportation systems. The direct costs of the current automobile system include the cost of the parking facilities, the cost to operate and park automobiles, and the cost to improve and maintain the roadway. The direct costs of the bus system are the capital, operating, and maintenance costs of bus equipment; the cost to improve and maintain the road traversed; and the cost to build and maintain park-and-ride facilities. Indirect cost factors are limited to travel time costs and accident costs, due to lack of data on others. For dual-mode trips (automobile and bus), costs are calculated according to an approximation of the length of travel by each mode. Inflation was not considered in this analysis, since the rate would be the same for all of the proposed alternative systems and thus would not affect the comparative results. An interest rate of 10 percent/year was used in the economic cost analysis of this study.

ENUMERATION OF BENEFITS

Most benefits (such as the environmental and economic impacts) are subjective in nature, and an estimation of them in measurable terms is often difficult. In this study, the user benefits of a given transportation improvement were expressed in terms of engineering economy, including savings in user's travel time, vehicle operating and maintenance costs, accident costs, and road maintenance costs. All nonuser benefits were considered in the decision-making process through a rating scheme.

DEVELOPMENT OF EVALUATION AND DECISION PROCESS

The evaluation and decision made use of the rating method combined with benefit/cost analysis to rank different alternatives. This was proposed because many project effects are not easily measured in comparable units. Consequently, a productive approach is to organize project impacts according to those factors that can be evaluated in dollar terms to be included in benefit/cost analysis and those nonqualitative community impacts to be incorporated into the rating procedure. The overall procedures are briefly outlined as follows.

First Step—Determining Benefit/Cost Ratio

The benefit/cost ratio method expresses the ratio of equivalent uniform annual benefits (or their current worth) to the equivalent uniform annual costs (or their current worth). In most highway benefit/cost analyses, the costs and the benefits are expressed on an annual basis. Any alternative that has a benefit/cost ratio greater than 1.0 is assumed to be economically feasible. This part of the analysis is limited to tangible factors only.

The following equation illustrates the general form of the benefit/cost ratio used in this analysis:

$$B/C = [-(U_P - U_B) - (K_P - K_B)] \div -(I_P - I_B)(CR,i,n) + (T_P - T_B)(SF,i,n) \quad (1)$$

where

U = uniform annual road-user costs, exclusive of road-user taxes but inclusive of travel time value and accident costs when so designated;
K = total uniform annual expense of administration, traffic services, highway operations, and highway maintenance;
I = construction investment at time 0 or at any time subsequent to time 0, or the equivalent present worth of all investments;
T = terminal value at the end of the analysis period (in most analyses for economic evaluation and for project formulation, the terminal value may be assumed to be 0);
B = the base alternative (the existing situation or defender);
P = the proposed alternative (the challenger);
(CR, i, n) = capital recovery factor; and
(SF, i, n) = sinking fund factor.

Equation 1 uses the concept of cash-flow diagrams, wherein cost of investments and annual expenses of highway maintenance or road-user expenses are negative and the flows of income or benefits are positive.

The benefit/cost ratio ordinarily will be negative because the numerator (benefits) usually will be positive and the denominator (costs) will be negative; when the numerator is positive, a positive sign will be affixed to the benefit/cost ratio; when the numerator is negative, the net benefits are negative and the alternative should not be considered further.

The different parameters in the benefit/cost ratio for this study are

1. U_B (present system in terms of annual costs) + costs to operate and park the automobiles + travel time costs + accident costs,
2. U_P (proposed system in terms of annual costs) = bus fare cost + road maintenance costs + park-and-ride terminal access costs,
3. K_B (present system in terms of annual expenses) = road operation costs + road maintenance costs,
4. K_P (proposed system in terms of annual costs) = road operation costs + road maintenance costs + bus facilities operating expenses + bus facilities maintenance expenses,
5. I_B (present system) = sunk cost that has already been invested in the road facility and has no relevance to the future, and since it is the same for all of the alternatives, there is no need to consider it in the analysis,
6. I_P (proposed system) = capital costs of the buses + costs of building park-and-ride facilities,
7. (CR, i, n) = (CR, 10%, 5 years), and
8. $(T_P - T_B)$ is assumed 0.

Second Step—Assigning Weights to Alternative Effects

A simple procedure to establish the relative importance of categories in the intangible factors (with and without benefit/cost ratio derived from the tangible factors) is to allocate 100 points to each member of an advisory group that represents all community sectors and citizen groups. Each member is asked to assign these points in accordance with personal perception. After all members have voted for their interests, the points are averaged. The results of average points for all alternatives would be the weights that represent the collective preferences of all parties involved.

Third Step—Rating Alternative Effects

Since intangible factors cannot be put in a common unit such as the dollar, a relative scale must be established for rating the merits of alternative transportation plans. A scale of -3 to +3 is used to indicate the estimated magnitude of alternative effects. Using the current system as a base for comparison, the positive value of the scale reflects favorable effects, whereas the negative value means unfavorable effects. All concerned effects are assigned a large, medium, small, or negligible rating for each alternative plan. The values that correspond to the general ratings are multiplied by the weights for the concerned effects, and a total is then assigned to each alternative. After all alternatives are subjected to this procedure, they are ranked based on their total scores. The alternative that has the highest score in the final analysis is chosen to alleviate the canyon transportation problems (2).

DATA COLLECTION AND PROJECTION

As indicated earlier, this study was concerned with an immediate action program of transportation improvements in the canyon. A two-year time lapse (1978-1980) was assumed before the implementation date. Analysis data were obtained from various published sources or through interviews with related agencies. Due to space limitation, this paper avoids a lengthy discussion of data collection and projection procedures involved in this study. The reader may refer to the full project report for further information (3). Only the following specific facts are presented briefly:

1. Automobile data—A previous study indicates that the average vehicle occupancy of canyon traffic is 2.7 persons/vehicle. The heavy traffic volumes and concentration of the daily and hourly peaks normally occur in the winter months (19 percent of the 30 highest peak hours occurred in January and February). The morning peak hours (9:00-11:00 a.m.) and the evening peak hours (4:00-6:00 p.m.) for the weekends carry, respectively, 60 and 40 percent of traffic during that period (4).
2. Small shuttle bus data—The capital cost of a shuttle bus was estimated to be $19 000. The operation and maintenance costs per bus were estimated to be about $1.30/km ($0.80/mile). The average speed of small shuttle buses in both directions between five park-and-ride terminals in the SLMA and the mouth of the canyon was predicted to be approximately 70 km/h (45 mph). The average speed of small shuttle buses in both directions between the mouth of the canyon and the canyon ski resorts was assumed to be 40 km/h (25 mph).
3. Large bus data—The capital cost of a large bus was estimated to be $80 000. The operation and maintenance costs per large bus were estimated to be about $2.60/km ($1.60/mile) for the canyon road conditions. The average speed of large buses in both directions between five park-and-ride terminals in the SLMA and the mouth of the canyon was taken to be approximately 65 km/h (40 mph). The average speed of large buses from the mouth of the canyon to the ski resorts was estimated to be approximately 35 km/h (20 mph).
4. Parking data—Based on the available data, the parking operation and maintenance costs at the ski resorts were taken to be about $250/space in 1980. The total cost of building park-and-ride facilities at the selected SLMA locations is estimated to be about $1 800 000 in 1980. Also, a park-and-ride facility at the mouth of the canyon would cost approximately $2 200 000 in the same year.
5. Road and bus use cost data—It was assumed that the road operation and maintenance costs would be the same for all different alternative systems. There are basically two reasons for such an assumption: (a) a lack of accurate data to specify the cost for each system and (b) although the road operation and maintenance costs seem to be higher for the heavier vehicles like buses, the less frequent use of the road by these vehicles (due to a larger passenger capacity) tends to offset the additional cost. Regardless of small or larger buses in use, $2.00/person from the park-and-ride terminals in the SLMA to the ski resorts and back was assumed, whereas a fare of $1.00/person from the mouth of the canyon to the ski resorts and back was used.
6. Estimated travel demand data—Statistics show that the increase in traffic on the canyon access road has been a function of recreational and lodging facilities at the ski resorts. The current total lift capacity is approximately 6000 skiers/h and the total lodging available is about 650 rental units. Approximately 20 percent of vehicles surveyed were out-of-state vehicles (4). Based on all available historical data and estimated increase in ski facilities in the future, a traffic projection was made for 1977-1982. The average daily traffic during this period was found to follow a leveling-off trend, as depicted by the dotted line in Figure 1. This future trend would be largely brought about by limitations in the skiing space and the ski lifts to be available.
7. Weighting survey data—The goal and objective priorities used in the evaluation analysis were measured by 14 questionnaires, which were sent to all interested parties, including the Utah Department of Transportation, Salt Lake County Planning Commission, Alta Planning Commission, Ski Developers, and skiers. Only 8 questionnaires were completed and returned. The percentage of the total used to reflect trends was based on the returned questionnaires.

EVALUATION OF ALTERNATIVE SYSTEMS

Based on a 12-h daily operation, the average number

Figure 1. Average daily traffic projection of canyon access road.

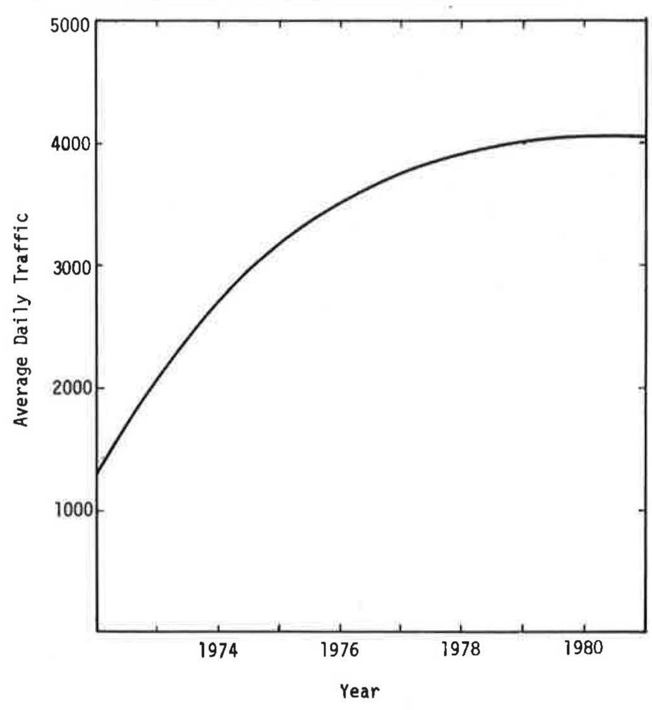

Table 1. Proposed alternative bus systems characteristics.

Type of Vehicles	Number of Buses	Operational Headway (min): Between SLMA Terminals and Resorts	Operational Headway (min): Between Canyon Mouth Terminal and Resorts
Large buses (40 passengers)	11	15	10
Small shuttle buses (14 passengers)	32	3.5	3
Mix of large and small buses			
Large buses	5	35	25
Small shuttle buses	18	6.5	4.5

Table 2. Overall score of alternative bus systems.

Effects	Alternative 1	2	3	4	5	6
Cost/benefit	46	92	92	138	46	138
Natural resources and quality of environment	31	31	93	93	62	62
Economic impacts	0	23	23	23	23	23
Total	77	146	208	254	131	223

Note: Score = weight x rating.

of buses and headways required to fulfill the need of proposed alternative systems for the years 1978-1980 are given in Table 1.

The value of the benefit/cost ratio for each one of the proposed alternative systems was calculated using Equation 1 with $(T_P - T_B) = 0$. The results are given below.

Bus System Alternative	Benefit/Cost Ratio
Exclusive use of large buses between five SLMA terminals and ski resorts	1.20
Exclusive use of large buses between canyon mouth terminal and ski resorts	1.65
Exclusive use of small shuttle buses between five SLMA terminals and ski resorts	1.45
Exclusive use of small shuttle buses between canyon mouth terminal and ski resorts	1.91
Mixed use of large and small shuttle buses between five SLMA terminals and ski resorts	1.36
Mixed use of large and small shuttle buses between canyon mouth terminal and ski resorts	1.77

Responses to survey questions regarding possible transportation-related changes revealed clear public preferences for selected future transportation policies. The benefit/cost analyses combined with the weighting survey have produced the final overall score for each alternative system. The tables below give the results of the conducted weighting survey.

Respondent	Environmental Quality	Economic Impact
1	70	30
2	40	60
3	50	50
4	70	30
5	65	35
6	85	15
7	60	40
8	25	75
Average	58	42

Respondent	Intangible Factors—Environmental Quality and Economic Impacts	Tangible Factors—Elimination of Traffic Congestion and Parking Problems
1	60	40
2	30	70
3	40	60
4	70	30
5	85	15
6	60	40
7	40	60
8	50	50
Average	54	46

The survey results indicate that 58 percent of the respondents rate the effects of improved transportation on the environment to be more important than the economic impact on the community. Also 54 percent thought that the intangible factors are more important than the tangible factors. A linear utility function was assumed for simplicity in this study so that the scales of rating project effects are employed in the following manner. For the tangible effects, the benefit/cost results from 1.20 to 1.40 in value are assigned a scale of +1; those from 1.40 to 1.70, a scale of +2; and those from 1.70 to 2.00, a scale of +3. Each alternative system was assigned a scale based on a subjective evaluation of the adverse intangible effects produced by that system relative to the other systems. The overall evaluation of the results is tabulated for all of the proposed alternative systems in Table 2. From the final scores, the most favorable alternative would be alternative 4, which is exclusive use of small shuttle buses between the mouth of the canyon and the canyon ski resorts. The second and third best are alternatives 6 and 3, respectively. Each of these three alternatives has a score above 200 and is superior to the other alternatives (1, 2, and 5). Although alternative 4 has the highest score, alternatives 6 and 3 are quite comparable and should not be completely precluded for consideration (if for one reason or another alternative 4 cannot be implemented). The score is an arbitrary rating of such alternatives, but the rating result allows some objectivity in comparison of alternatives. Decision makers may use the rating for guidance but ultimately will remain responsible for their decision.

CONCLUSIONS

The purpose of this study was to adopt a practical methodology for short-range transportation improvement that is fully responsive to the typical problems of recreational resources. The methodology was tested by using the case of Little Cottonwood Canyon of Utah. The breadth of the system considered, the parameters developed, and the evaluation and decision-making process were structured so that the material can be used in similar recreation resorts. Emphasis was placed on simplicity and practicality of the methodology, maximum accessibility, and minimum negative environmental impacts.

In order to alleviate transportation problems and protect environmental qualities, this study suggests that a park-and-ride bus transit system, directed toward low-capital-cost improvement as an immediate-action program, would be feasible for the canyon service. Comparison of several alternative bus transit operations shows that private vehicles should logically be replaced by public transit in response to increased ski demand and environmental degradation in the ski season. The comparative analysis included consideration of level of transport service capacity, capital and operating costs, and essential nontransport impacts. All interested parties were consulted to determine the desirability of proposed alternatives. The alternatives were compared by adding the individual ranking for a score through the suggested procedure. The exclusive use of small shuttle buses to provide transportation service between the mouth of the canyon and the ski resorts was found to be relatively more attractive on the basis of economic factors and community responses.

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Impact of Population and Energy on Transportation Needs: Multimodal Approach

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This paper documents a computer process developed to explore the potential diversion of automobile trips by purpose and length for various population growths and energy futures and the impact this diversion will have on transportation needs. The technique is a straightforward method of using the existing statewide transportation model to generate statewide highway trip tables for each possible future. These tables are split by trip purpose based on analysis of actual statewide origin-destination data and then split into modes based on trip purpose and length information gained in the survey of air, rail, and bus travel characteristics. Information on the modal split in other mass transit corridors in the United States is also used as a guide. The variables in this process are easily understood and thus may be quickly adjusted to reevaluate transportation needs and to reflect various planning policies. Once the modal trip tables are generated, they are assigned to a statewide air, rail, or bus network based on station accessibility; the remaining trips are assigned to the highway network. The end product is a computer plot that shows the potential travel volumes by mode and the probable impact of each population growth and energy future on state highway needs. This technique is being applied in rural portions of 13 of Michigan's 14 planning regions.

Determination of which highway construction projects are necessary and establishment of priorities requires analysis of numerous alternatives. Since planners must be aware of potential changes in social and economic conditions, a process of measuring the impact of these changes on travel patterns and demands must be developed to identify critical deficiencies and to evaluate various construction programs.

Recent federal legislation, increased public involvement, and changes in social and economic problems have created many new issues that must be resolved by transportation agencies. The Federal-Aid Highway Program Manual (1) states, "It is the FHWA's [Federal Highway Administration's] policy that... appropriate consideration be given to reasonable alternatives, including the alternative of not building the project and alternative modes." It further states that an action plan should identify procedures to be followed to ensure that "... alternatives containing new transportation modes or improvements to existing modes are adequately considered, where appropriate."

Many alternate transportation modes suffer due to population dispersion and erratic public response; but recent public emphasis on energy conservation may cause future travel patterns and demands to change. Consequently, in order to forecast future transportation needs, a transportation planner must be able to estimate population growth rates and identify major areas of change. It has, therefore, become imperative for transportation agencies to consider the effects and interaction of at least three major influences on travel patterns:

1. The related effects of energy availability and cost,
2. The increased emphasis on alternative modes, and
3. A growing and potentially shifting population.

The problem of defining future transportation needs