Framework for Classifying and Evaluating Economic Impacts Caused by a Transportation Improvement

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Economic principles involved in conducting benefit-cost analysis of a transportation investment have been discussed at length in the literature, but there are few articles that provide a synthesis of the main components of the analysis and evaluation process. First, an attempt will be made to distinguish between transportation user benefits and economic impacts from a transportation improvement. Although some of the economic impacts are intuitively recognized, they have not been clearly identified or completely recognized. As a result, the evaluation process has been less than complete. A system for classifying the economic impacts and methods of measuring these impacts are suggested for discussion. Second, a framework for the evaluation of the improvement costs, transportation user benefits, and economic impacts from a transportation improvement is presented.

Consideration of social, economic, and environmental factors has traditionally been part of the transportation plan evaluation and the environmental impact assessment process. Although the environmental and social impacts of a transportation improvement have been well recognized and classified, not all the economic impacts have been identified in any systematic manner by their relative significance or magnitude. Often, transportation user benefits result from savings in travel time, in avoiding delays at railway crossings, in operating a vehicle, and in avoiding accidents. These savings are mistakenly attributed as economic impacts. An array of methods for determining user benefits of transportation projects is available, but how the different types of economic impacts are measured and evaluated in an integrated manner has not been demonstrated adequately in the literature. As background information, a brief description of techniques currently used is provided, and comments are offered on the limitations and problems generally associated with these techniques.

Within a region, transportation is closely linked to economic activity. Consequently, economic development is linked with the transportation system and at times this relationship is almost symbiotic under a scenario of economic renewal. Continued development of these economic corridors is vital for maintaining the economic health of the state or province, but also poses special problems. The growth in employment and activity centers, housing, and associated traffic places a heavy burden on the transportation infrastructure. This growth creates demands for system expansion, degrades Provincial highway mobility (i.e., the through movement of traffic), and imposes constraints on future developments. These burdens often cannot be met with existing or anticipated resources because traditional funding mechanisms for the much-needed transportation improvements appear to be inadequate.

An assessment of the expected change in economic activity or its potential for growth within a selected economic corridor then becomes an important consideration in improving and expanding transportation services. Administrators, engineers, and planners are continually called on to make decisions relating to investment choices for developing corridors. However, now, more than ever, they find themselves subjected to increasing pressure for justification of capital expenditures. These increasing demands come from the ever-growing lobby and interest groups who often hold conflicting objectives, from the public who feel the effects of inadequate infrastructure needs, and from central agencies who must determine the priority of major capital expenditures on infrastructure needs (including transportation systems). As a result, decisions concerning capital investments for transportation corridors are becoming increasingly complex as planners attempt to assess, weigh, and evaluate social, cultural, and environmental factors in addition to economic factors in determining a preferred investment strategy. On the basis of an analysis of total primary user benefits and costs, the traditional method by itself is considered inadequate when negotiating for funding of transportation improvements.

OBJECTIVES

The objectives are (a) to distinguish between transportation user benefits and economic impacts, (b) to present a system for the classification of the economic impacts caused by a transportation improvement, and (c) to suggest a simple framework for evaluating the transportation benefits, costs, and economic impacts resulting from a transportation improvement, from the dual standpoint of relevancy and feasibility. Furthermore, some aspects of the reality and problems of economic evaluation are emphasized.

For ease of discussion and treatment, the subject is confined to the roadway mode. However, the analysis framework is equally applicable to other transportation modes as well. For purposes of discussion, the term "impact" is treated synonymously with "effect" and the term "improvement" refers to a transportation improvement.

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TRANSPORTATION BENEFITS AND ECONOMIC IMPACTS

Discussion of Benefits and Impacts

A regional highway network basically serves a number of population centers, industries, and markets and consists of a number of roadway links providing both mobility and access. The addition of a single link to the existing highway network or an improvement to the network generates transportation user benefits (and disbenefits) from the day the improvement is first used, whereas economic impacts occur almost from the day construction begins. The total benefits and impacts that result from improving a single link of the network are never realized immediately. In other words, a stream of benefits flows over time, with the economic effects not fully felt in the region until production and marketing economies and cost savings resulting from the improvement are incorporated into freight rates, pricing structures, and production levels. A subtle distinction therefore exists between transportation user benefits and economic impacts of a transportation improvement.

Transportation User Benefits

The primary purpose of transportation capital expenditures is to provide new and improved transportation services to maintain quality of service. Transportation user benefits measured in terms of time savings, savings from avoidance of delays at bridge or river crossings, vehicle operating cost savings, and savings from accident reduction on transportation improvements are the primary effects of transportation improvements. These transportation user benefits are the main components of benefit-cost analysis, which provides a quantitative assessment of the relative benefits of different alternatives in terms of a common measure—namely, dollars. However, other benefits to users such as ride comfort, convenience, and availability of emergency services cannot readily be reduced to dollar terms. Measures of effectiveness have been used to deal with benefits that are not easily quantified or reduced to dollar values. But, such usage is not common in highway engineering economic analysis. Procedures to measure the value of user benefits are discussed under benefit-cost analysis.

Economic Impacts

Economic impacts measure the secondary effects of capital expenditures on the regional economy. They affect income, employment, and production and generate tax revenues and consume resources. In order to assess the overall economic impact, it is important to first identify and classify the individual impacts. They are broadly categorized into the following three types:

- Direct impacts are consequences of economic activities carried out on site in the construction and operation of an improvement. Employment of labor, purchasing of goods and services, and taxes paid are examples of activities that generate direct impacts. The use of the improvement by vehicles is also a source of direct impacts.
- Indirect impacts derive primarily from offsite economic activities associated with production of intermediate goods and services required for the construction and operation of the improvement. Some of these activities include services provided by aggregate, asphalt, steel, and concrete suppliers. These enterprises employ labor, purchase goods and services, and consume resources. The indirect impacts differ from direct impacts in that they originate entirely offsite.
- Induced impacts are the multiplier effects of the direct and indirect impacts. As income expands because of direct and indirect effects, households increase their purchases of goods and services, thereby giving rise to still further changes in production and corresponding changes in the other impact variables. For example, most of the wages earned by the construction workers is spent in the region. Some of this spending becomes income to individuals who provide goods and services to the construction crews and also for local businesses and their employees. As successive rounds of spending occur, additional income is generated.

However, if the goods and services are imported to the region, the benefits to the region are reduced proportionately. An excellent discussion of caveats regarding the regional import component and other examples of the application of economic impacts is found in Butler and Kiernan (*1*).

Therefore, total economic impacts are the sum of the direct, indirect, and induced impacts.

In a study of economic development in smaller cities, Malizia (*2*) suggests that economic benefits might be distinguished between economic growth benefits (purely quantitative increases) and economic development benefits (qualitative increases, such as increases in the diversity of employment, which contributes to the stability of a local economy). This concept appears to have some relevance in the understanding of economic impacts.

At this point, before the introduction to the classification and evaluation framework, the major tools and techniques available to the analyst for estimation of transportation benefits and economic impacts are reviewed. They are in no way exhaustive; NCHRP Synthesis of Highway Practice 142 (*3*) contains an overview of highway economic analysis procedures.

Analytical Techniques

Some techniques available for determining the transportation benefits and economic impacts follow.

Benefit-Cost Analysis

The best known technique for measuring the efficient use of available resources is benefit-cost analysis, in which the benefit-cost ratio (*B/C* ratio) is examined. Benefit-cost analysis, techniques for which have been comprehensively covered in the literature (*4*), is an accounting of all benefits and costs for each alternative plan and a selecting of the alternative that yields the most benefits per unit of cost. In prac-

tice, complications arise because many of the effects of a transportation improvement cannot be measured easily.

There are three principal methods of evaluating the efficiency of transportation investments. The first method examines the ratio of the total benefits to total costs. In this method, the investment alternative with the highest *B/C* ratio provides the largest return per investment dollar. The second method examines the net benefits (or net present value) produced by each alternative. Total costs are subtracted from total benefits and the option with the largest net benefits is chosen as the best investment option. A third method is the incremental benefit-cost ratio, in which the costs and benefits of each alternative are compared with the cost and benefits of the next alternative, beginning with the least expensive option. As long as the resulting incremental benefits exceed the added cost, it is best to invest in the next higher cost option (*5*).

Associated with the benefit-cost analysis is present-value or present-worth analysis. A stream of benefits and costs occurs at different times during the life of the improvement. Because these yearly benefits change, discount rates must be applied to convert all benefits and costs to a present value. As is the practice in many jurisdictions, the appropriate discount rate to be applied is the average rate of return that can be expected on private investment before taxes and after inflation. This choice of discount rate is based on the fact that funds expended for a transportation improvement are not funds that would otherwise stand idle. The government obtains these funds from the private sector, either by taxation or borrowing, and if left in the private sector the funds would be used to generate a return as do other investments. When the funds are diverted to public use, the cost of the diversion is the return that otherwise would have been earned. This cost is considered to be the opportunity cost of capital. The results of the benefit-cost analysis may be sensitive to the discount rates used. Some of the computerized program packages available for the determination of user benefits and costs are described in the following paragraphs.

- Priority Planning System (PPS). In 1974, the Ontario Ministry of Transportation developed a computerized method for the systematic assessment of highway improvement priorities so that improvements could be implemented in such a way as to optimize benefits to the general public (*6*). This method was considered state-of-the-art for a long time and was the subject of NCHRP Project 8–18, conducted by the Maryland Department of Transportation. NCHRP Report 199 describes the PPS in detail (*7*). The first two stages of this computerized program can be used independently to estimate road user cost and hence the benefits to the users. PPS calculates three user benefits for each improvement alternative as follows:

1. Travel time savings—change in user's travel time cost because of the improvements;
2. Vehicle operating savings—change in road users' vehicle operating costs because of the improvement; and
3. Accident savings—change in costs because of the improvement. They are divided into three types: fatal, personal injury, and property damage accidents.

Positive savings occurring because of the improvement (i.e., a reduced user cost after the improvement) are called benefits, whereas negative savings are called disbenefits.

- The Highway User Benefit Assessment Model (HUBAM). HUBAM is a computer model similar to PPS, but unlike PPS, this model can include rehabilitation and upgrading projects (*8*). Now operational at Transport Canada, the model is currently being used in the evaluation of new highway agreements with some of the provinces.

Input-Output Analysis

Input-output (I/O) analysis provides a framework within which industrial linkages and the feedbacks between consumers and the producing sector of the economy can be simulated. The approach involves modeling the economy in a set of linear equations that can be solved mathematically. The cost of the new construction or improvement is obtained from the preconstruction cost estimates or from costs incurred on a comparable project adjusted suitably to reflect the conditions of the project evaluated. The construction cost estimate and other project parameters form the input to an I/O model, which in turn generates the impacts of the construction activity.

The Ontario Ministry of Transportation has developed an interactive computer model known as the Transportation Impact Model (TRIM) to calculate the economic impact of capital investments in transportation infrastructure (*9*). TRIM is based on the I/O model of the Ontario economy.

The identification and classification of economic impacts are discussed in the following paragraphs.

CLASSIFICATION OF ECONOMIC IMPACTS

An efficient transportation network connecting business and industry with markets and suppliers is important to a region's continuing economic vitality. Improvements to the network help existing firms become more competitive and make the region more attractive for new business as well.

The most important step in assessing the economic impact of an improvement is to ensure that all the issues have been identified for examination. The economic impacts of an improvement may be broken down as affecting the following areas (*10*):

- Business and industry,
- Residential,
- Tax revenues,
- Regional and community, and
- Resources.

Other important aspects of impacts are that they vary in the degree of permanence (i.e., the effects can be temporary or permanent) and that they are considered either beneficial or detrimental. For this paper, temporary impacts are those that are short lived on a site-specific basis, often lasting only for the duration of construction. Impacts of a more lasting nature would then be categorized as being permanent. Using this definition, the relative importance of the different classes

can be established. Those impacts considered to be permanent and classified as producing direct, indirect, and induced effects would rank higher against an impact classed as temporary and having only indirect effects.

The following analysis attempts to understand and limit the boundaries for the categories within these five classes. This restriction is necessary to avoid the double counting of impacts in the assessment stage.

Business and Industry

Economic activity in a corridor is the sum total of the activities occurring in each sector of the economy. All categories of business activity may be affected by a transportation improvement through changes in the levels of employment and income resulting from changes in accessibility, economic stimulus from construction, and acquisition of land for the right-of-way. Negative effects from pollution and indirect effects in the economy can also result from an improvement. An improvement could also influence locational decisions of firms. The preponderance of industry impacts will vary depending on an industry's dependence on transportation.

In order to develop a process of assessing the potential impacts, they may be grouped under the following subheadings:

Effects of Facility Construction on Business

Improvements in a corridor generally yield three types of economic impacts:

1. Direct expenditures on labor and materials used on site for construction and recurring expenditures on labor and materials required for maintenance;
2. Secondary effects induced by direct expenditures (i.e., they affect income, employment, and production inside and outside the state or province; generate tax revenues; and consume energy sources); and
3. Possible temporary losses to firms in the vicinity of the construction area because of decreased accessibility.

Right-of-way acquisition costs will be excluded from actual construction expenditures as they are handled as a separate item in the next subsection. Also, the economic activity induced by wages and sales is assumed to be contained within the region, and no leakage is considered. In practice, construction workers may come from outside the region and sales income may accrue to companies located outside the region as well.

Effects of Right-of-Way Acquisition

Expansion of the existing right-of-way by acquisition of additional land could lead to the displacement of business establishments in the corridor and have the following effects:

1. Net loss of jobs and services should displaced businesses choose to relocate outside the region or even to cease operations.
2. Redistribution of jobs and services within the corridor or the region.
3. Loss of land required for the right-of-way.

Further, businesses outside the right-of-way may suffer loss of customers if the right-of-way creates a barrier, such as in the case of a divided highway, that hinders access to and from them (*11*). This type of impact is more permanent in nature than the disruption caused by construction discussed previously.

The number of jobs and income losses can be estimated for a route alignment. Estimates may be provided on the basis of employment and sales of establishments in the affected corridor.

Effects on Business Growth

Transportation investments often provide an impetus for business growth. This growth may occur in manufacturing, service, wholesale, or retail sectors of the economy and may include the following:

1. Expanding existing businesses;
2. Attracting new business or labor to the corridor;
3. Deterring growth of other businesses and those that depend on remoteness (e.g., wilderness recreation amenities);
4. Reducing the cost of moving goods and raw materials, which may enhance the competitive position of existing businesses and thus encourage regional development and expansion (see 1);
5. Servicing interregional traffic flows, which can encourage the development of travel-related businesses (see 1 and 2); and
6. Redistributing traffic patterns, which may depress economic development of areas where traffic is reduced (see 3).

The direct impacts lead to indirect effects on the economy such as additional orders for materials and equipment from other businesses. For example, expansion of the hospitality industry leads to additional orders for linen, fresh and frozen foods, and a host of other supplies. Also, there are induced effects that result when new businesses hire more workers who then spend money on consumer products and services. The resulting overall impact on business will be reflected in terms of sales, income, employment, or other economic indicators, and these impacts are normally induced, after completion of the facility.

Although there are several ways to evaluate these economic impacts (i.e., increase in income or wages) the simplest measure is the additional disposable income resulting from the new jobs created by all the direct, indirect, and induced effects.

Effects on Tourism and Recreation

Where tourism or recreational activity is regarded as an important sector in the region's economy, a transportation improvement can have positive or negative effects on the industry and requires inclusion in any accounting of impacts.

Improved accessibility stimulates tourism and recreation in much the same manner that it stimulates business growth. Highway improvements, especially expansion from two to four lanes, save travel time, reduce safety hazards, and make

travel more predictable to various tourist and recreational centers. Industry experts believe that the stimulus is proportional to the degree of change in accessibility that the improvement creates. Where improved accessibility makes travel safer, faster, and more enjoyable (especially to lake areas), the waterfront lots increase in value.

An improvement can also have negative effects on the tourist industry of a region when a certain measure of remoteness is desired, such as for the operation of fly-in tourist resorts. Also, if accessibility to a tourist area is increased without regard to the supply of sufficient facilities, competition for limited tourist and recreational facilities could discourage tourists. Furthermore, a new alignment, which bypasses a recreation or tourist area, can divert potential users away from existing facilities, resulting in a reduction in facility usage.

Increase in tourist spending will impact certain sectors of the economy directly whereas other sectors are unaffected. Visitors spending money in hotels, lodging facilities, gas stations, restaurants, and grocery stores generate demand for agricultural products, petroleum, etc. The retail and service sectors generally experience the highest increase in sales and employment. Money spent by tourists circulates through the economy, creating indirect and induced economic impacts. Additional sales and employment result in other industries such as manufacturing, services, and transportation that supply goods and services to the hospitality and recreation industries because of direct spending.

Techniques for assessing the incremental demand and the corresponding impacts of improved accessibility from an improvement should be undertaken by a recreational or tourism planner. Essentially, the assessment involves estimating highway use for greater visitation and spending patterns by trip categories, such as hotel or motel trips, camping, seasonal home visits, visits to friends and relatives, and day trips. Interviews with owners and managers of hospitality, recreation, and tourism businesses would help to assess the potential future visitor spending. An important factor to be considered is the potential negative impacts of improvements increasing the attractiveness of other regions for study area residents.

Effects on Agriculture

In many rural or suburban areas, through which highways are located, agriculture is the dominant economic activity. Improvements from a two- to a four-lane facility, particularly, would enhance accessibility and mobility.

A transportation improvement may affect agricultural activity as follows:

1. Improved Accessibility to Markets to Increase Profitability. Improving accessibility may result in lower transportation costs for moving produce and farm supplies, thus leaving more money in the hands of the farmers. Also, farmers may be able to shift to more valuable crops as a result of improved access. This conversion to higher-value crops can result in increased productivity. Furthermore, an entirely new corridor of travel could open new markets, thus enabling farmers to produce more agricultural commodities or more profitable ones.

2. Encouraged Conversion of Agricultural Land to Other Uses. Improved accessibility in a corridor may increase employment opportunities and the increased activity may result in pressures for conversion of agricultural lands to other "highest and best" uses such as residential, commercial, or industrial. The permanent loss of valuable farm land to urban development is of concern to most people, hence, the assessment of this impact is sufficiently important to warrant special attention. It has been noted that interchange points are more susceptible to early development or zoning conversions.

3. Change in Agricultural Productivity. Agricultural productivity of a region is estimated by the output of the region measured in terms of the quantity of commodities produced and the income generated. Shifts to more valuable crops increase productivity. However, transportation facility construction could also affect farm operations adversely because of siltation and altered drainage patterns and severance of farms by the right-of-way, not to mention the reduction of farmland from right-of-way acquisition.

An assessment of the incremental productivity and the economic impacts of a transportation improvement on farm land can be made in consultation with an agricultural economist.

Effects on Mining and Forestry

In other rural or remote areas, highways provide access to mining and forest resources. Improvements result in lowering of transportation costs, thus enabling operators to remain competitive. An assessment of the incremental productivity and the economic impacts of an improvement on mining and forest resource industries is similar to that of agriculture.

Residential

Residential development (i.e., the construction of new dwelling units) is a function of economic growth and housing market variables such as immigration, employment, population growth, income changes, rate of household formation, decreased housing inventory through aging or demolition, and availability of building sites. The effects of a transportation improvement in this impact category may be as follows:

- Induced or secondary effects of employment growth in the regional economy may also attract additional workers and families to a region, thus creating an additional demand for housing.
- Reduced housing stock from right-of-way acquisition may cause relocation and replacement housing needs.

Although the impacts are linked closely, the scope of the assessment here can be confined to the following effects.

1. Replacement and Relocation Housing Needs. The right-of-way requirements and the associated residential relocation implications can be determined for each option considered. The reasonableness of the estimate should be discussed with realtors and others knowledgeable about housing and socioeconomic conditions. At times, according to U.S. experience, families from minority groups experience difficulty in securing alternative accommodation. As a last resort, relocation hous-

ing may have to be acquired or constructed to carry out any relocation program.

2. Induced or Secondary Effect on Residential Construction. In addition to causing residential relocation, a highway improvement may also affect residential construction by inducing the construction of new housing units. At the local level, lower-cost lands are made more attractive to developers and home buyers because of improved accessibility. However, at the regional level increased business activity generates additional employment and population in the region, requiring additional housing.

It is important to distinguish between induced residential construction from improved accessibility to some areas, and induced construction from positive overall growth in the economy. The former mainly causes a redistribution of construction activity within the region, whereas the latter results in a net increase, not necessarily limited to the local impact corridor.

Tax Revenues

Any expenditure, such as for a transportation improvement, generates tax revenues for the different levels of government. In Ontario, more than 35 percent of the total cost of an improvement is recovered by government from personal taxes, indirect business tax, tariffs, and local property and business tax. From the TRIM model, the federal government collects the largest portion, about 18 percent of the investment cost, whereas the provincial government recovers about 12 percent and the local governments about 5 percent of the project cost. The magnitude of the capital returned to government has not been stressed sufficiently.

Although the magnitude of the federal and provincial taxes recovered is much larger, their impacts are not location-specific. The impact on the improvement area can be attributed mainly to property and business taxes, which determine the level of public services and facilities provided to the community.

Property Taxes

Property taxes are the primary source of revenue for local governments, and their impacts can be divided into two areas:

1. Loss of Tax Revenues from Acquisition of Private Property. Using local tax rolls, the assessed value and the annual tax for each parcel of land affected by acquisition can be determined. A computation to account for the extent of losses from the acquisition can then be made.

2. Changes in Property Values and Tax Revenues. An improved highway may increase accessibility to an area and boost property values, by making properties more attractive for commercial, industrial, or high-density uses. On the other hand, undesirable environmental and safety effects may depress property values. These market value changes for the land may be reflected in assessed values and, hence, the property taxes. The effect of these changes is long lasting.

Experience shows that the level of development induced by a new or reconstructed corridor is often greater than anticipated. Commercial and industrial growth yielding positive tax benefits is desired by local municipalities.

In conducting the analysis, the changes in property value can be considered as follows:

1. Changes in Value from Accessibility. In general, the increase in property value resulting from improved accessibility can be further subdivided into two types: (a) increase in value from making the property more attractive or useful from reduced travel time, etc., and (b) increase in value from making the property attractive for a more intensive purpose such as a shopping center or plaza.

2. Decrease in Value from Environmental Effects. Estimates of the degree to which property values will decline from environmental effects are highly subjective. The important factor is people's perception of the situation. A study of a large subdivision in Toledo showed that lots adjoining a freeway sold at comparable prices to interior lots but more slowly. This occurred at a time when a majority of realtors in the area felt that property near the freeway would be of lower value (*12*).

3. Changes in Value from Other Positive Effects. Occasionally, a highway improvement will provide benefits to adjacent properties other than from improved accessibility. An example of this type of impact could involve a reduction in air pollution by providing for public transportation and by eliminating congested locations.

The effect of a transportation improvement on property values should be estimated in consultation with realtors and appraisers who are knowledgeable about property values.

Public Service Changes

Impacts in the area of public services can be attributed to the following:

- Changes in net public expenditures (i.e., new tax revenues less the cost of providing additional public facilities and services to accommodate the new growth).
- Public expenditures for replacement of displaced public facilities.

The analytical procedure of estimating public service requirements associated with induced residential development could follow a three-step approach:

1. Estimate public service requirements in relation to the estimate of the households and residential units resulting from induced development.
2. Review capacities in existing facilities because they may have excess capacity and be capable of accommodating additional demand.
3. Compare anticipated public service requirements and the capacities of present and planned facilities to reveal the additional public services required to service the incremental growth.

Estimating the scale, timing, and location of induced development in an improvement corridor is no simple task.

Regional and Community Activity

Transportation facilities, together with water, sewer, and other public utilities, are major determinants of urban development and economic growth. Transportation facilities also reinforce land use planning and economic development objectives in rural areas by providing access to agricultural lands, tourist attractions, and natural resources. An improvement can be expected to encourage economic growth of a region as well.

Occasionally, an improvement that is required to provide mobility for regional travel could conflict with plans for a housing project or a public facility, such as a hospital or school. A highway agency could also be unaware that a building in the demolition zone has been designated as a historic structure. Liaison with other planning agencies and early identification of such situations is required to avoid conflict.

An improvement may affect a community

- In terms of the general pattern of community growth;
- In terms of public revenues and expenditure;
- In terms of direct income; and
- In terms of environmental conditions.

These effects are somewhat interrelated and the assessment of impacts in this area can generally be reduced to two categories by asking the following questions:

1. How does the improvement relate to adjacent land uses?
2. How will the induced development relate to the existing uses?

In attempting to answer these questions, one realizes that the impacts under this activity relate to a broader context of economic and land use planning at the regional or province-wide scale. Unless the project has system-wide repercussions, consideration of impacts under this activity may not be warranted in the case of area-specific projects.

Resources

The construction and operation of a transportation improvement require the direct consumption of resources, thus creating potential economic impacts on four broad resource types (i.e., land, labor, materials, and energy).

The assessment of impacts on resources involves the determination of energy consumption associated with direct, indirect, and induced effects of the project. Standardized impact values available from I/O models of energy consumption for standard-unit projects can be used to estimate the effect of direct impacts.

Appreciation of Land Values

Transportation improvements enhance the desirability of locations within the catchment area of the improvement corridor. This increased desirability stimulates the demand for land at those locations. Because the supply of land is fixed, increased demand leads to escalation of land rents, which in turn results in higher land values. The increase in land values results from the reduction in transportation costs to users. Inclusion of this as an economic benefit leads to double counting the effects of transportation improvements (*13*). An aggregation of the estimated increase in land values of all parcels of land within the catchment area would yield an overall measure of the value of an improvement to the community or society at large.

Note of Caution

When funds normally allocated for a capital construction program are involved that would generate economic benefits to the province or state as a whole, then it is inappropriate to attribute the economic impacts to the transportation improvement.

Classification Summary

A summary of the different categories of economic impacts is presented in Table 1. The foregoing discussion has indicated that the consequences of an improvement can be broadly categorized as direct, indirect, and induced, and that they vary in the degree of permanence.

BASIC EVALUATION FRAMEWORK

A basic framework integrating the different components of the evaluation process is shown in Figure 1. The framework consists of the following components.

Set of Goals and Objectives

The framework requires a clear statement of goals and objectives. Goals are generalized statements indicating the direction in which society is to move. An objective, on the other hand, is a specific statement that is the outgrowth of a goal. Objectives are attainable and stated so that it is possible to measure the extent to which they have been attained. Some simplified examples of desirable state or provincial objectives for transportation in general could be

- To provide transportation services for the mobility of people and goods;
- To preserve the transportation system now and for the future;
- To ensure safety, effectiveness, and environmental acceptability;
- To ensure that the expectations of various stakeholders are reconciled; and
- To promote economic growth.

Associated with these objectives is the implicit understanding that they be achieved at reasonable cost.

The degree to which the objectives are attained is defined by criteria. One particular type of criterion, known as a stan-

TABLE 1 CLASSIFICATION SUMMARY—ECONOMIC IMPACTS

Class	Category	Effects	Direct	Indirect	Induced	Temporary/ Permanent
Business & Industry	Facility Construction	Expenditure on labour and materials for construction	x			T
		Secondary effects induced by direct expenditures		x	x	T
		Losses to firms in the vicinity		x		T/P
	R-O-W Acquisition	Loss of jobs and services due to relocation	x			T
		Redistribution of jobs and services within the corridor		x		T
		Loss of land	x			P
	Business Growth	Expansion of existing businesses	x	x	x	P
		Attract new businesses or labour	x	x	x	P
		Deter businesses that depend on remoteness	x	x	x	P
	Tourism & Recreation	Expansion of existing businesses	x	x	x	P
		Deter businesses that depend on remoteness	x	x	x	P
		Divert potential business	x			P
	Agriculture	Increase or decrease in productivity and profit	x			T
		Encourage conversion of land to other use		x		P
	Mining & Forestry	Improved accessibility to markets	x			P
Residential	Regional Economy	Replacement & Relocation housing needs		x	x	T
		Attracts additional workers and families		x	x	P
Tax Revenues	Property Taxes	Loss of tax revenues due to acquisition	x			P
		Property value changes and associated tax revenues		x	x	P
	Public Service Needs	Require additional expenditure			x	P
Regional & Community	Community Region	Changes to pattern of community growth				?
		Changes to public revenues and expenditure		x		?
		Gain or loss in direct incomes	x			?
		Environmental changes				T
Resources	Land	Covered under R-O-W acquisition	-	-	-	-
	Materials & Labour	Covered in effects of facility construction	-	-	-	-
	Energy	Consumption associated with direct, indirect and induced effects	x	x	x	P

dard, defines the cutoff point above or beyond which performance is rejected (*14*). Irwin (*15*) classified criteria into social, economic, physical, fiscal, and aesthetic types. Absolute criteria could be applied to meet minimum standards in social, physical, and aesthetic areas to which dollar values may not be readily applied. Having eliminated alternatives that do not meet the minimum level, relative criteria could be applied in the economic and fiscal areas to provide a basis for selecting the preferred improvement that produces the most benefits in relation to cost. Therefore, physical and aesthetic areas will be combined as environmental considerations.

If need be, a relative ordering of the objectives could signify the importance attached to each objective. For example, a highway improvement necessary for the revitalization or stabilization of a disadvantaged or declining area could be selected even if the improvement is only marginally viable in terms of system productivity.

Goals, objectives, and criteria will be highlighted for the purpose of assisting the decision makers to focus on the task when making the ultimate choice between feasible alternative improvements and are to be used more as reference devices. In the context of current knowledge pertaining to consensus

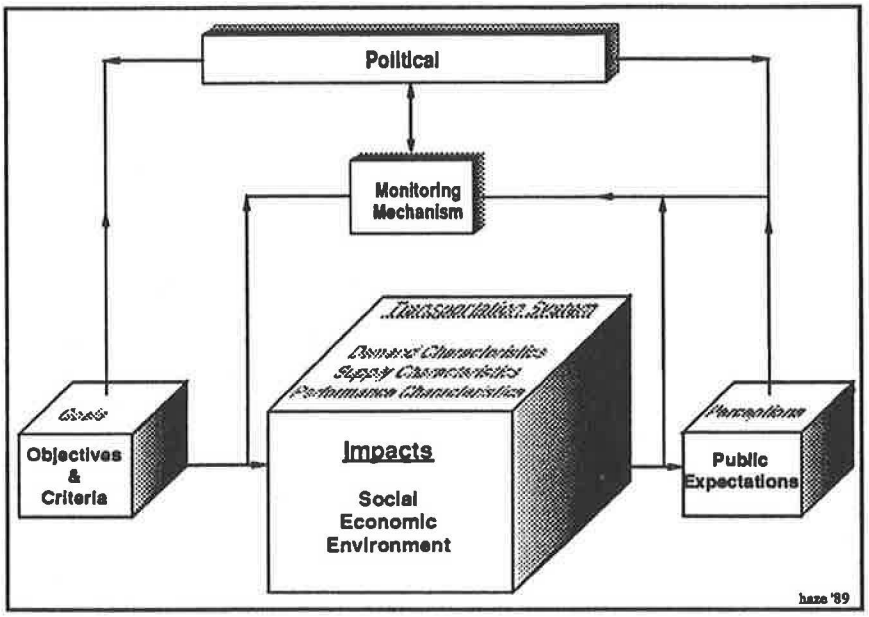

FIGURE 1 Evaluation framework.

building, it is desirable that the objectives be agreed on as being the most relevant to decisions. Without consensus, a strategy is weakened from dissension among the stakeholders. The political process thus provides the forum for discussion and reconciliation of conflicting stakeholder interests.

Transportation System

The transportation system can be characterized in terms of its

- Supply characteristics (capacity, operating costs, level-of-service, etc.);
- Demand characteristics (land use, demand for travel, etc.); and
- Performance characteristics (accident rate, vehicle-km of travel, etc.).

The consequences that occur as a result of the activity associated with a transportation system can be categorized into three main impact areas, namely social, environmental, and economic.

Public Perceptions

Public perceptions involve stakeholder interest and participation by the public with their perceptions of the transportation system. Information for a public perceptions study can be collected from newspaper clippings or articles relating to transportation issues in the corridor of interest and by interviewing business persons and community leaders. Review of correspondence from the public might also provide useful insights.

The Ministry of Transportation Ontario recently carried out a public opinion survey to determine the perceptions of Ontario residents regarding the adequacy of highway transportation services from a general standpoint, but included an analysis of a few specific corridors as well.

Monitoring Agencies

Departments of transportation normally act as the monitoring agencies. The planning and control elements in these organizations review the status of the existing system, assess system performance against the program objectives, consider public concerns, project future needs, and plan measures to correct existing or anticipated system deficiencies.

Any major deviation between the system's performance and expectations would necessarily activate a response from the institutional component of the monitoring system.

Political Process

This is the most important component of the framework. However, its linkage with the other components of the system tends to be tenuous. An important consideration for planners and administrators to recognize is that the mechanics of the political process call for more emphasis on short-term issues at the expense of longer-term considerations.

APPLICATION OF THE FRAMEWORK

The selection of objectives and criteria applied to judge relative priorities of the project or preferred improvements form the initial stage of the framework. As suggested by Irwin (*15*), absolute criteria satisfying minimum standards in the social and environmental impact areas are applied to select those projects to be tested for economic viability. The selection and definition of criteria form an important part of the public participation process.

Planners and analysts guided by the objectives and criteria set and review the supply, demand, and performance characteristics of the system within the study area. The application of economic analysis and the evaluation of viable options is the outcome of this stage.

The results of the preceding evaluatory stage are then made public, and feedback obtained regarding public perceptions and satisfaction is used to improve the project selection proc ess further. Where possible and feasible, conflicting stakeholder interests are resolved.

The final stage of the entire process is the reconciliation of any residual conflicting stakeholder interests and the selection of the project for implementation, which is a political decision.

The following subsections outline briefly the methodology involved in evaluating the economic impacts from a highway transportation improvement.

Improvement Alternatives

The typical highway improvement involves the expansion of an existing two-lane highway to four lanes. Generally, four improvement alternatives can be considered as follows:

1. Status Quo, No-Build, or Do-Nothing Alternative. This alternative is not an improvement in the strictest sense, but rather provides a benchmark against which to measure changes in costs and benefits of the other three basic improvement alternatives in the following discussion. This alternative represents the costs incurred to provide normal maintenance to keep the improvement in a satisfactory condition.
2. Combination 2-Lane–4-Lane Alternative. Four-lane sections are proposed only where required to accommodate increased traffic volumes. This capacity improvement would be effective throughout the life cycle of the facility according to the transportation agency's normal highway improvement plans.
3. Freeway-Expressway Alternative. This alternative expands the existing two-lane highway by adding two additional lanes to provide for a four-lane divided highway basically on the existing alignment. The expressway design allows some at-grade intersections (i.e., direct access only at major arterial urban roads) rather than requiring access to the highway through expensive interchanges.
4. Freeway Alternative. This alternative consists of a full four-lane divided highway designed to the highest standard. A higher speed limit than the freeway-expressway alternative is allowed. In order to maintain a constant speed limit, much of the facility may be required to be built on a new alignment with bypasses around communities and access to the highway via interchanges.

Variations of these basic alternatives can be considered as well. The evaluation process consists of the estimation and comparative assessment of improvement costs, user benefits, and economic impacts for each of the preceding options considered within the transportation system for the entire study period.

Improvement Costs

Improvement costs relating to each study alternative can be determined by using unit cost estimates. Such cost would include construction, rehabilitation, and maintenance expenditures. Because some of these costs vary from one-time costs (construction) to costs incurred more than once (rehabilitation) to annual costs (maintenance), the cost stream over the study period for each alternative is discounted to current dollars. This allows a comparison of relative costs for each alternative.

Potential User Benefits and Economic Impacts

In order to select the best investment strategy, comparing the improvement costs of each alternative with its potential benefits and impacts is necessary.

Using models of travel behavior, the existing and future traffic (for the system as is) in the study corridor can be estimated. Computer assignment programs are then used to simulate new traffic and travel patterns for each of the improvement alternatives. With each successive level of improvement, the corridor may attract more users from other routes. These traffic volumes become the basis for the estimation of user benefits and economic impacts over the entire study period.

The transportation user benefits for the three improvement alternatives, in relation to the do-nothing alternative, can then be determined using existing computer packages such as PPS, HUBAM, etc. In this context, the current NCHRP Project 7-12, Microcomputer Evaluation of Highway User Benefit, should prove to be an invaluable tool for the analyst.

The estimation of the economic impacts for the three improvement alternatives form an integral part of the total benefit package. In a previous section, an attempt was made to identify and classify the different economic impacts, and methods of estimating the magnitude of these impacts were suggested. The future user benefit and economic impact stream is discounted to their equivalent present value as is the improvement cost. The freeway alternative would provide the greatest economic impact because the expressway and combination alternatives are less attractive for industry because of increased travel times, reduced travel ranges, and a general perception that any highway with less than freeway standards provides a less safe and relaxing travel environment.

The suggested methodology for some impacts is not entirely satisfactory because of the interaction between impact categories. It is suspected that there is some leakage and the author perceives that this could be an area for further research. As indicated by Table 1, business growth, recreation and tourism, facility construction, and property tax, in that order, appear to be important impact categories. Estimation of impacts in these areas would account for the greater part of all economic impacts.

A matrix of improvement costs, user benefits, and economic impacts for the improvement alternatives considered for a hypothetical case are presented in Table 2.

Evaluation of Improvement Alternatives

A benefit-cost analysis may then be carried out to determine if the benefits (both user benefits and economic impacts) resulting from an accelerated construction program exceed costs, and if so, which improvement alternative can be expected

TABLE 2 PRESENT VALUE OF COSTS, BENEFITS, AND IMPACTS (1988 DOLLARS IN MILLIONS)

	Combination Two-lane - Four-lane	Freeway - Expressway	Freeway
Improvement Cost:			
Construction	300	450	550
Maintenance	20	50	70
Total Cost	320	500	620
User Benefits:			
Travel Time Savings	500	750	900
Vehicle Operating Savings	10	-35	-125
Accident Savings	150	200	300
Sub-total	660	915	1075
Economic Impacts:			
Facility Construction	420	630	770
Business Growth*	500	1200	1500
Tourism & Recreation*	100	250	350
Sub-total	1020	2080	2620
Total Benefits & Impacts	1680	2995	3695
Tax Revenues	90	135	165

** Note: Figures shown above are hypothetical for purposes of illustration*

to provide the best return. Table 3 presents a summary of results. Some aspects of the benefit-cost analysis process were discussed under analytical techniques.

The array of improvement costs, transportation user benefits, and economic impacts for improvement alternatives, together with the results of the benefit-cost analysis, may then be presented to the political decision makers and even to the public. Final decisions should, quite properly, be made at the political level, which involves debate and trade-offs between individuals and groups who hold conflicting views.

The planners should ensure that all facts are made available and presented in a manner that is understandable in order that an informed political decision can be made. It would be a mistake to avoid the scrutiny of the political decision-making process by reducing the evaluation of alternatives to a numerical exercise.

CONCLUSION

The distinction between transportation user benefits and economic impacts has been explained. An understanding of the three types of impacts (i.e., direct, indirect, and induced) would assist in identifying economic impacts. Some economic impacts from a transportation improvement have been identified in previous studies. Additional economic impacts, some of which appear to be significant, have been identified and arranged into generic groups.

As an integral part of the classification of impacts, the effects of such impacts have been recognized. Some impacts can be placed in more than one class type, illustrating the complex nature of the impacts and their interrelationships. Also identified in the classification is the degree of permanence of the impacts. Naturally, impacts classed as permanent are considered more significant than temporary impacts.

A ranking of the impact categories has not been assigned. However, from the tabulation of impact categories, business growth, recreation and tourism, and property tax appear to be significant categories on the basis of the degree of permanence and incidence of impact types.

Methods of measuring the magnitude of some of the economic impacts are suggested. In view of the interrelationship between the different impact categories, further research is suggested in the area of assessment of their magnitude and method of aggregation.

TABLE 3 BENEFIT-COST ANALYSIS (1988 DOLLARS IN MILLIONS)

	Combination Two-lane - Four-lane	Freeway - Expressway	Freeway
Present Value of Benefits & Impacts (B)	1680	2995	3695
Present Value of Costs (C)	320	500	620
Net Present Value (B - C)	1360	2495	3075
Benefit - Cost Ratio (B/C)	4.25	4.99	4.95

A simple framework for the evaluation of the improvement costs, transportation user benefits, and economic impacts associated with improvement alternatives is presented for discussion. This framework requires that minimum standards be satisfied in the social and environmental impact areas before an alternative routing is included in the evaluation process.

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