Transport Project Appraisal in Israel

Yoram Shiftan, Nir Sharaby, and Charles Solomon

Major investments in transport projects currently under way in Israel account for 1.2% of gross domestic product. The government is allocating budgets for new roads, intercity rail lines, and mass transit systems in all major metropolitan areas, with a growing share of private financing of public infrastructure. The government issued a new guide for transport project appraisal in 2006 to improve the decision-making process and the efficient allocation of funds. The guide is a result of substantial research and comprehensive review of worldwide developments, positioning project appraisal technique in line with best practices and state-of-the-art transport economics. The paper focuses on the main methodologies and changes in the new guide. The 2006 guide broadens the project impacts taking into account cost–benefit analysis (CBA) and thus reduces potential bias among different types of projects. New safety and environmental impact analysis are now part of CBA. Other impacts include equity analysis and accessibility and level-of-service indices. Special attention was given to improve the interaction between the transportation model and the economic model, integrating the various project impacts under a broad systematic analysis. Benefits are calculated based on welfare theory, and a special procedure is introduced to evaluate the potential bias under fixed demand travel demand models. It was shown that benefits are usually overestimated by use of the fixed demand assumption. These overestimates are negligible under normal flow conditions, but the bias is high under congestion conditions and elastic demand.

Investment in transport infrastructure improves mobility and is considered to have a major effect on economic activity and growth. National accounts of European Union countries show that the transport sector amounted to 8% of their gross domestic product (GDP) (*1*). Although there is significant evidence of the economic impact of transport infrastructure, its actual contribution to the GDP or welfare is a subject of great debate among researchers [see for example Banister and Berechman (*2*)].

In Israel, the Ministry of Transport and Road Safety is in charge of transport policy, infrastructure financing, and strategic planning; and local authorities are in charge of project planning, building, and maintenance. Intercity roads are planned, built, and maintained by the Israel National Roads Company. Intercity rail is planned, built, and maintained by the Israel Railways Company.

Transport infrastructure investment accounts for 1.2% of Israel's GDP (2006). Investments increased significantly during the past decade (67% since 1996), and the Ministry of Transport and Road Safety aims to reach an annual investment of 1.9% of GDP by 2011.

Israel's government is allocating budgets for new intercity rail lines and mass transit systems in all major metropolitan areas with a growing share of private financing. As a result of this policy change, the public transport share of total investment has increased dramatically from 5% in 1996 to almost 50% in 2004–2006 (see Figure 1).

Project appraisal is carried out for all new infrastructure investments. The appraisal framework aims to assist decision makers in the building and advancement of projects that will improve accessibility, safety, and the environment; contribute to economic growth and the national economy; and maximize social welfare. The uniqueness of the appraisal framework is in integrating all project impacts under a broad systematic analysis of the project and transport network.

The first official project appraisal guide titled *Transport Projects Manual* (*3*), published in 1996, was based on the cost–benefit analysis (CBA) technique and included new features and methodologies. Before this guide, project appraisal was carried out to best practice but was not necessarily consistent and comparable. The 1996 guide was appropriate for road projects and set new national standards for project appraisal, but had serious limitations in evaluating public transport projects and projects in congested areas.

In 1998 the government, recognizing the guide's limitations, initiated reassessment of the methodology for the purpose of using a better evaluation procedure and values mainly for rail projects. In response, recommendations for methodological improvements were introduced by the Hague Consulting Group (*4*) aiming mainly to improve public transport appraisal capabilities. However, this work was not adopted as part of the official guide.

The need for an improved guide has grown gradually. New complex projects under planning, including major mass transit systems and various transport policies, demand a more realistic modeling and evaluation process. Private-sector financing of transport projects is becoming more and more popular and requires specific consideration. Theoretical developments and new approaches toward traffic safety, environmental impacts, and equity considerations have increased the requirement for broader project impact assessment.

The new 2006 guide, *Transport Project Appraisal (TPA)* (*5*), is a result of substantial research aimed at dealing with the new needs and putting project appraisal technique in line with best practice and theoretical developments. The guide is currently available only in Hebrew; this paper describes its main elements and some of the new research that was incorporated into it.

LITERATURE REVIEW

Many researchers and agencies are involved in the research and improvement of appraisal methods. Most research in this area has been conducted by various institutions seeking to improve their own methods, along with some academic research. Most notable are the

Y. Shiftan, Transportation Research Institute, Technion City, Haifa 32000, Israel. N. Sharaby, NSH Strategic Investment, 89 Yehoshua Bin Noon Street, Tel Aviv 62497, Israel. C. Solomon, Economics and Planning Department, Ministry of Transport and Road Safety, 5 Bank Israel Street, Jerusalem 91950, Israel. Corresponding author: Y. Shiftan, shiftan@tx.technion.ac.il.

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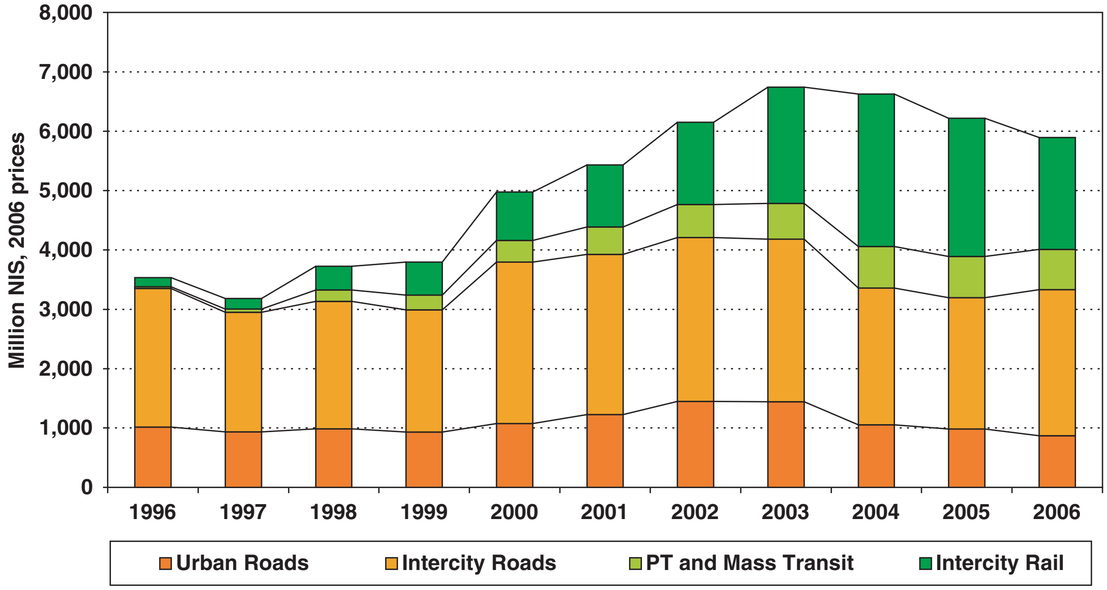

FIGURE 1 Land transport infrastructure budget, 1996–2006.

United Nations Forum of Ministers for Research; World Bank; European Conference of Ministers of Transport (*6*, *7*) and various European Commission research projects, mainly European Network; and TCRP in the United States (*8*). Academic research has focused on a wide area of related topics such as benefit estimation, modeling of decision support and uncertainty, socioeconomic impacts, network effects, public transport value of time, multicriteria evaluation, and application issues.

Methods of project appraisal differ among various countries as a result of distinct histories of the development of theoretical and practical application. For good reviews of the specific methods used in different countries see Vickerman (*9*) for Great Britain, Rothengatter (*10*) for Germany, Quinet (*11*) for France, Morisugi (*12*) for Japan, Lee (*13*) for the United States, Bristow and Nellthorp (*14*) for the European Union, and Talvitie (*15*) and Kerali (*16*) for developing countries. Finally, Hayashi and Morisugi (*17*) provide an excellent international comparison.

There are various methodological issues associated with appraisal, and the topic is well covered in the literature. Mackie and Preston (*18*), for example, list 21 sources of error and bias in the appraisal of transport projects. These relate to objectives, definitions, data, models, and evaluation conventions. The base of CBA is common to all appraisal frameworks. For general background of CBA, see among others Sugden and Williams (*19*) and Layard and Glaister (*20*).

An alternative approach to CBA is a multicriteria analysis (MCA), presenting various impacts of the project in a summary table. MCA is often seen as competing with CBA, although there is no reason why the two approaches may not be used in an entirely complementary manner in the overall framework, and lately there are various cases in which the two methods are combined. As an example, Tsamboulas and Mikroudis (*21*) describe EFECT, a generalized methodological framework for evaluating the impacts resulting from transportation projects, with a specific orientation to environmental impacts. The expert Transport Investment Evaluation group in Europe developed a summary and synthesis of various European appraisal reports and envision a joint CBA/MCA model as the most effective way to pursue project appraisal (*22*). Its review of European practice reveals that many countries have a strong historical tradition of MCA in a transport appraisal context and that others include some form of MCA procedure in an overall appraisal framework.

Various decision support systems were developed to help decision makers evaluate complex choices on the basis of enhanced access to information of different types. For example, Brand et al. (*23*) describe the outcome of a European research project called STEEDS (scenario-based framework for modeling transport technology deployment: energy–environment decision support). Tsamboulas and Mikroudis (*21*) describe the presentation of results within the EFECT framework, whereby the use of an additive function combining MCA and CBA methods provides the simple and intuitive understanding of results. Other examples of decision support systems are presented by Colorni et al. (*24*).

Both the United Kingdom and Japan have developed summary tables, the Appraisal Summary Table in the United Kingdom (*25*) and the Benefit Indices Table (BIT) in Japan (*26*), as tools presenting a summary of the evaluation results to decision makers. See Morisugi and Ohno (*27*) for theoretical background of BIT, and for an example of quantitative BIT see Nakamura (*28*).

TRANSPORT PROJECT APPRAISAL GUIDE 2006

The Ministry of Transport and Road Safety and the Ministry of Finance published the *Transport Project Appraisal (TPA) Guide* in 2006. The combined efforts of the two ministries were essential for the successful development and implementation of the new guide. The new methodology is a result of extensive research work and comprehensive review of worldwide methodologies aimed to put project appraisal technique in line with best practice and theoretical developments. The TPA 2006 defines a formal procedure that must be carried out before approval of any transport project on the state, regional, and city level.

Objectives of the New Guide

Compatibility with Economic Theory and New Transportation Models

An effort was made to base the new methodology mainly on microeconomic theory, welfare theory, and willingness to pay. The new appraisal framework is consistent and compatible with the latest generation of transport modeling. The new generation of activity-based models is currently being developed for the Jerusalem and Tel Aviv metropolitan areas; plans for additional metropolitan area models, as well as a national model, are in progress. The development of these models uses the latest theories and technologies including the Global Positioning System and cell phones for travel information. These new-generation models will provide enhanced capability to deal with today's planning needs, such as congestion mitigation and various policies, and will contribute to more realistic analysis of project appraisal and policy decisions.

Public Transport Oriented

Over the years, the Ministry of Transport and Road Safety's policy has shifted toward public transport projects as the core infrastructure investment in major urban areas and in major intercity corridors. The TPA 2006 contains many methodological improvements that are more suited to both highways and public transport projects (*29*). Multimodal corridor study is now part of the evaluation procedure applied to major corridors, making sure public transport is not neglected. Accounting for a broader range of externalities in the procedure reduces potential bias among different types of projects (*30*).

Urban Oriented

Congestion is more severe in dense urban areas and on major access roads to main cities. The introduction of a new scheme that takes into account the difficulties in using travel demand models to evaluate the impact of improved congested facilities, together with the new benefits mentioned above, is much more effective in targeting urban projects.

Main Improvements in the New Guide

Improvements in the new guide include

- General methodology. A new and improved methodology of project appraisal based on CBA with elements of MCA, multimodal and advanced interaction between the economic model and the transportation model, including treatment of induced demand, congestion, and door-to-door time.
- Project impacts. The new guide aims to include more project impacts and benefits. New safety and environmental impact analysis is now part of the CBA. Other impacts include equity analysis and accessibility and level-of-service indices. Other impacts, such as economic and regional development and reliability, may be assessed separately as a sensitivity analysis, but no specific methodology is assigned for that purpose.
- Project costs. Cost guidelines include a new set of vehicle operating costs, more conservative guidelines on how to treat project cost assessment at the planning stage, new methodologies of road maintenance cost assessment (*31*), and traffic delay costs during the construction period (*32*).
- National database. A new database, containing detailed car accident history, official detailed population and employment forecasts, operating costs, and project evaluation results, is supplied with the guide (*33*). Such a database provides better and more consistent values for evaluation.
- Risk analysis. New risk analysis is introduced as part of the evaluation. The project's major risks are identified, and risk analysis is carried out in the form of scenario and sensitivity analysis.
- Equity analysis. The CBA gives a relatively clear measure of a project's economic impact on a national level. However, the government is also interested in the distribution of these benefits and burdens over different groups of the population. The new equity analysis for the TPA 2006 suggests focusing on the most important goal of a transport project—the improvement of people's ability to travel. The analysis is conducted and presented separately from the CBA (*34*).

General Methodology

The core of the appraisal framework is the CBA, compiling measured impacts into monetary values and calculating standard financial decision criteria: net present value (NPV), internal rate of return, and benefit–cost ratio (*35*). These measures account for the various elements in the evaluations that are monetized including time saving, safety, and environmental impacts. Additional information is also presented in the executive summary table that functions as a multicriteria analysis (MCA) and includes accessibility indices and safety, environmental, and equity impacts—along with an overall project evaluation. These measured impacts give additional critical information that is not revealed in an NPV lump sum. No weights are provided to the different criteria, and they are simply presented separately so decision makers can make their own judgments about the importance of various elements in addition to the overall cost benefit. The executive summary table, translated from Hebrew, is presented in Figure 2. The information in Figure 2 is publicly available, but there is no formal process for accounting public input. This general methodology is in line with the practice in many countries that includes some form of MCA procedure in an overall appraisal framework (*22*).

As to the CBA, net benefits are discounted using a 7% discount rate during a period of 25 years—15 for small projects of less than NIS 50 million ($1 = NIS 4.3)—or 40 years for mass transit or large rail projects.

The CBA is conducted separately for each project to estimate its contribution to the network. The project is evaluated under the assumption of completion of other planned projects on the network. This type of analysis does not provide an investment plan and prioritization of the projects. However, the new guide recommends conducting sensitivity analysis with and without other adjacent planned projects, to support decision making on the network level.

PROJECT IMPACT: COSTS AND BENEFITS

Time Saving

Time saving is usually the most significant benefit in the cost–benefit analysis of transportation projects. Travel time is considered as opportunity cost, and reduced travel time provides improved

State of Israel

משרד התחבורה

Summary Table

Project	**Project Name**
Description	Project Description
Plans	Project Planning Status
Statutory	
Costs	Project Costs in Million NIS

Financial Analysis

million NIS	NPV	IRR	B/C
Total	**Value**	**Value**	**Value**
Operating Costs	Value	Value	Value
Passenger Time	Value	Value	Value
Safety	Value	Value	Value
Environment	Value	Value	Value

Recommended Year for Completion	year
First Year Cost Recovery	%
Cost Recovery Period (Years)	no. of years

Project Impact Sheet

	Index	Value	Notes
Accessibility	Annual Time Savings	Value	Passengers hours per year
	Average Travel Time Savings	Value	Percent
	Changes in the Level of Service	Value	for example: from E to D
	Change in Public Transport LOS	Value	Additional supply (Vkmt) per day
	Change in Pedestrian Accessibilty	Qualitative	Side-walk is shrinked by 70 cm
Safety	Annual Change in Accidents Costs	Value	Million NIS, 2010
	Fatality Estimated Change	Value	number on 2010
	General Assessment	Qualitative	Expected significant accidents reduction on rd. 6 cross-road
Environment	Noise	Value	Size of population exposed
	Air Qulity	Value	Increase in PM10
	Severance	Value	Size of area damaged
	Landscape	Qualitative	Type and description
	Other	Qualitative	
Social Equity	Household Equity Index	Value	Car-less are less improved
	Community Equity Index	Value	Weak communities improved
Overall Assessment	Other Impacts		
	Planning Notes		
	Assessment		

Recommendations

Summary	Appraisal conclusions, recommendations and special notes

FIGURE 2 Appraisal summary table (IRR = investment return ratio, B/C = benefit–cost ratio, LOS = level of service, Vkmt = total vehicle km, PM10 = particulate matter 10^{2} µm diameter or smaller).

accessibility. Value of time is used to monetize time savings and is therefore a critical value in the analysis.

Accordingly, in the new guide, significant effort was devoted to improving methodology and values in regard to time saving, rendering them compatible with worldwide practice and at the same time reflecting local values (*36*).

The principles adapted in the appraisal are as follows:

- Time is based on the travel demand model and door-to-door time, including access time and in-vehicle time.
- There is one value of time for all time components (in-vehicle and out-of-vehicle time), for all modes (private, public), and for all populations (age, income, geographic, and all other categories). This principle, common to many other countries, can be viewed as providing equal opportunities to poor and rich and to highway and public transport projects. Given that public transport users in Israel are from lower socioeconomic sectors, this policy also works to encourage public transport investment.
- Time is treated linearly, regardless of the amount of time saved. In other words, the value of time of 1 min saved is equal to the value

of time of 1 h saved. This is common practice, with few exceptions where small time savings are not accounted for, such as in Germany and Canada.

- Mean travel time is applied in the evaluation, as in other practices. However, time reliability is an important benefit of certain transportation projects (especially when exclusive right-of-way is provided) and can be accounted for in the evaluation. Specific methodologies are currently under development.
- Value of time should be based on the willingness to pay principle; commonly the national average wage is used as a proxy for willingness to pay and common practice is used to take a percentage of these values for different trip purposes.
- Value of time varies according to three trip purposes: work-related, commute, and all other. This is an improvement over the 1996 guide, in which the latter two were combined and a lower value was assigned to both. The new guide acknowledges the importance of commute trips to social welfare and, hence, a higher value of time was assigned to them.
- The official values of time for December 2006 prices are
  – Work-related: NIS 56.6 per hour ($13.2, 100% of wage rate),
  – Commute: NIS 17.0 per hour ($4.0, 30% of wage rate), and
  – Other: NIS 11.3 per hour ($2.6, 20% of wage rate).

Environmental Impacts

The environmental analysis in the new guide is a first attempt to include environmental considerations in the appraisal guide (*37*). Further research and development is currently being undertaken to improve the process. Default procedure based on the recommendations of the previous work by the Hague Consulting Group (*5*) can be used. The new guide treats four elements: air quality, noise, green areas and severance, and landscape. The first two items are monetized, and the last two are evaluated quantitatively but are not part of the CBA. Not all elements are required for all projects, and the guide specifies these occasions.

- Air quality. In the new guide, cost changes in air quality as a result of transport projects are estimated using human life values. Air quality impacts are estimated based on changes in PM10 as representative of the main pollution source. The change in cost takes into account the expected mortality rate with and without the project, the population exposed, and human life values of NIS 4.0 million. Secondary pollutants such as ozone and greenhouse gases are not considered at this stage. There is a significant variation in the type of pollutants that different countries include in their evaluations; only France and Japan also take into account global warming.
- Noise. There are various methods to estimate the cost of the effects of noise, including willingness to pay, past compensation determined by court, and effects on real estate values using hedonic models. The latter method was used in the new guide. According to the model, the factors affecting the cost of noise are change in level of noise, population exposed to the noise, the type of community exposed, and the type of project (rail versus road).
- Green areas and severance. The impact of the intrusion is a numerical measure taking into account the green area taken, its size, the way the transport project crosses the area, the type of infrastructure, and the sensitivity of the area given its natural and other values.
- Landscape. A numerical measure was also developed for the landscape effect, taking into account the population exposed, the view and visibility of the damage, the type of project, and the sensitivity of the area.

Traffic Safety

The Ministry of Transport and Road Safety conducted a series of empirical studies on the cost of accidents in Israel during the past few years (*38, 39*). The annual cost of accidents was estimated at NIS 12.6 billion, representing 2.5% of GDP, or $450 per capita (NIS 1,880). These costs include fatalities and injuries, pain and suffering, property damage, traffic delays, and administrative costs.

Evaluating the safety impacts of a transport project is not an easy task. Accidents occur irregularly, and the impact and costs differ significantly according to the severity of the accident, type of road and the vehicles involved, time of day, and other factors. Evaluating the effect of different accidents is heavily dependent on the availability of data to support this evaluation.

Considering the difficulties and data availability, the new guide introduces a series of guidelines to evaluate project impact on traffic safety:

- A national accident database has been established and includes several sources of data, detailed descriptions of accidents, and statistics from recent years.
- Project impact is measured in regard to the change in accident costs rather than in the number of accidents. This methodology naturally incorporates safety impacts into the CBA and, furthermore, it ensures that a correct weight is given to accident severity. The official cost of various types of accidents is presented in Table 1.

TABLE 1 Car Accident Costs by Severity of Accident

Severity	Cost
Fatal	
Fatality	NIS 4.7 million per casualty including damage to property
Severe injury	NIS 0.5–0.9 million—by location of accident and type of vehicle (car, bike . . .)
Light injury	NIS 17,000
Severe	
Severe injury	NIS 550,000–950,000
Light injury	NIS 17,000
Damage	NIS 3,000–60,000—by factor involved (car, bike, pedestrian . . .)
Light	
Light injury	NIS 17,000
Damage	NIS 2,000–40,000—by factor involved (car, bike, pedestrian . . .)

• The impact of specific safety elements on the number of accidents can be calculated based on empirical statistics. For example, urban traffic circles reduced accident probability by 57% to 62%, lighting in urban streets reduced night accidents by 18%, and intercity interchanges reduced accidents by 20% to 25%.

• The methodology uses the systems analysis approach to measure the impact in the project vicinity, including all the facilities that might be influenced by the project. A set of cost equations is given for intercity road analysis. These equations are described below.

One new element in the 2006 guide is the consideration of accident cost as a function of traffic volume on intercity roads. This cost is a result of the probability of an accident and its severity, which are functions of traffic volume and speed.

When there are no cars on the road, accident cost is zero by definition. When traffic is congested and travel speeds are low, the cost of accidents is minimal again, because only light accidents are observed in traffic jams. Empirical analysis of accident cost data and traffic data on uninterrupted intercity road sections in Israel was used to estimate accident costs as a function of volume to capacity (V/C). It was found that an accident cost on a section of road is at its maximum for traffic volume in which the V/C ratio is slightly less than 0.5. This may be explained partially by higher variance of travel speeds at that point, causing more severe accidents and setting costs of accidents at a maximum. This is demonstrated in Figure 3, presenting the official cost functions for single-, two-, and three-lane per direction intercity roads (*40*). This cost does not include delay cost, which is taken into account separately and obviously is increasing with V/C. It can be seen that accident costs are significantly higher on a single-lane road for almost all volume levels, suggesting that widening such road sections from a single lane to two lanes would result in high safety benefits.

INDUCED DEMAND AND CONGESTION

One of the main problems with the 1996 guide, as with many other international guides, is the assumption concerning fixed demand (*41*). Under this assumption a project has no impact on the total demand. This unrealistic assumption is problematic mainly in megaprojects. There are two sources of bias resulting from the fixed demand assumption. First, by definition, benefits to new users are not counted in the appraisal. Second, time saving to existing users is overestimated because speed is higher than in reality, as the assumption of fixed demand does not consider new users.

Figure 4 demonstrates this effect. Assume that there is a road section with regular supply function (representing time costs and other costs) that is increasing with volume (S_1). The demand is a decreasing function of total cost as shown by Line D, and an equilibrium is achieved at point *a*. Improving the road shifts the supply function to S_2 with new equilibrium at point *b*. At this new equilibrium point there is a consumer surplus gain to existing riders represented by the area *egha*, in addition to benefits for new riders represented by the triangle *ahb*. Under the assumption of fixed demand, the new equilibrium is at point *c*. At this point benefits for new users are underestimated (area *abh*) whereas benefits for existing users are overestimated (*ghcf*). In network terms, if the road improvement has shifted only route choice, then the equilibrium points *a* and *c* are consistent with the Wardrop equilibrium and the demand function represents changes in traffic volume resulting from other shifts, including mode and destination. Williams and Moore (*42*) investigated the relative size of these two areas under various scenarios of demand and supply. They found that at high levels of congestion with elastic demand, there is a significant overestimation of benefits under the fixed demand assumption, and under regular flow condition, this

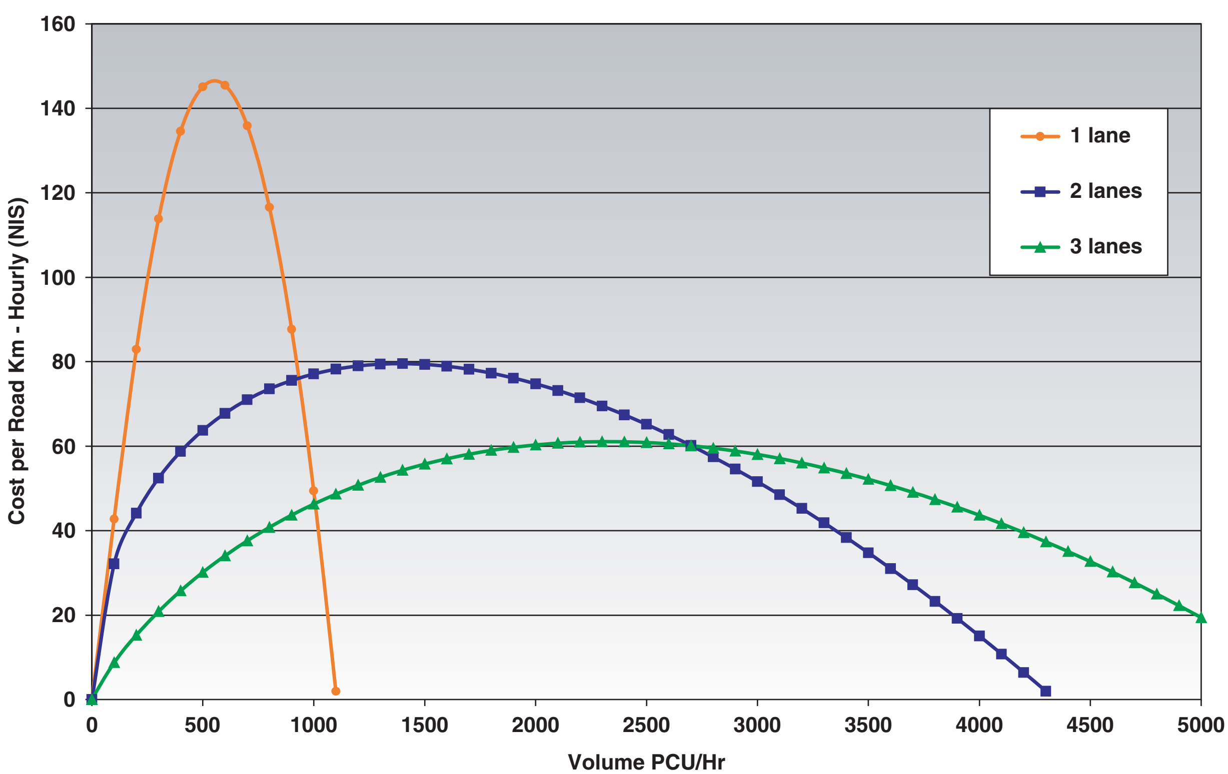

FIGURE 3 Cost of accidents by traffic volume, NIS per road kilometer, hourly and daytime.

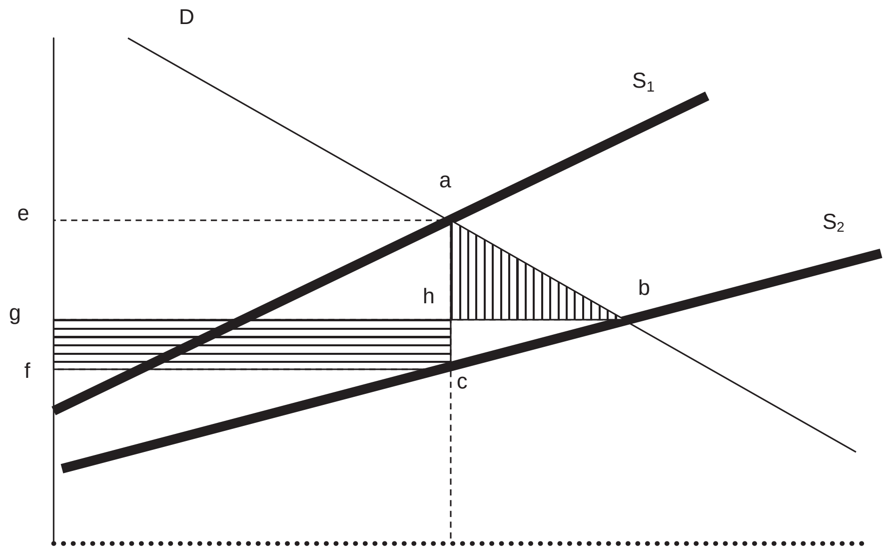

FIGURE 4 Potential bias under fixed demand assumption.

overestimation will be lower and may even underestimate benefits. Williams and Yamashita (*43*) extended this analysis to the project life cycle.

This issue is often referred to as induced demand. A new transport project attracts new users. These users can come from various sources: they may have previously used other modes, traveled at different times, or traveled to other destinations, or may be completely new users. Induced demand is defined in different ways in the literature (*44, 45*). However, in practice these new users represent the demand to use the facility and the induced demand is simply the demand that is not accounted for by the travel demand model in use. So, the issue of induced demand is basically the limitation of the travel demand model to represent all sources of new users, which is exactly the assumption of fixed demand. In most travel demand models in use today, the total number of trips is not sensitive to level-of-service variables. Therefore, an improved facility will not change the total number of trips, and this is commonly referred to as induced demand. New activity-based models are being developed in many places today including the two main metropolitan areas of Israel, Tel-Aviv and Jerusalem. These advanced models derive the demand for trips from the demand for activities and have the advantage of being more sensitive to level-of-service variables, including at the trip generation levels (*46*), and thus accounting for induced demand.

The problems associated with the fixed demand assumptions and current travel demand models used for evaluation can be summarized as follows:

- The effect of fixed demand assumption on highway versus public transport projects. The assumption of fixed demand may cause bias in the evaluation of different types of projects. Specifically, the bias described above as overestimating the benefits of time saving refers mainly to highway projects. Ignoring induced demand in highway project evaluation also underestimates various negative externalities, mainly air quality. In public transport projects, however, the assumption of fixed demand has marginal effects on the level of service; therefore the overestimation of time saving for new users is marginal. However, the underestimation of benefits for new users may be significant.
- Ignoring the relationships between transport and land use. Improvements in the road system encourage sprawl. In the lack of a combined land use transport model, this effect is not accounted for and total vehicle kilometers may be underestimated.
- Unrealistic travel times. One of the main problems with current travel demand models is that travel times under congested conditions are unrealistic. This results from the static nature of many of the models in use today and their inability to deal with traffic queues. To cope with the capacity constraint problem, volume delay functions are highly sensitive at congestion. Therefore, for any small improvement in a congested network, the model will show significant time saving, overestimating the benefits. A partial solution for the congestion situation under fixed demand models is a postprocessor recalculating travel times and speeds. This procedure was adopted in the 2006 guide.
- Insensitivity of the model to time shift. Many of the traditional models lack a behavior-sensitive time-of-day model. Various research studies show that time shift is one of the main responses to congestion [see for example Raney et al. (*47*)]. This causes overestimation of traffic in congested periods, also resulting in overestimation of benefits.

TREATMENT OF INDUCED DEMAND AND CONGESTION IN THE NEW GUIDE

As presented above, fixed demand models suffer from bias in benefit estimation. The travel demand model commonly in use in Israel today is the traditional four-step fixed demand model. The new guide takes this type of model into consideration, as well as the newly developed activity-based model.

- For the new activity-based model with sensitive demand, the benefits are calculated as the changes in consumer surplus using the standard rule of half as shown in Figure 4.
- When fixed demand models are used, the guide suggests using sensitivity analysis to estimate a range of benefits. In addition to the fixed demand analysis, a range of elasticity values for each origin–destination pair is assumed, and the benefits are recalculated

accordingly. Although this is not the right theoretical solution in which a more sensitive travel demand model should be used, it can provide an estimate of the potential bias in benefits from the fixed demand assumption.

- Better estimation of the time saving of network improvements under congestion should be carried out using microsimulation or queuing models. If such tools are lacking, a postprocessor should be used that estimates actual travel time using output from the travel demand models.

A case study is used to demonstrate the fixed demand bias under different congestion scenarios to illustrate the way the new guide suggests dealing with such bias. Assume a two-lane highway section with a length of 10 km, capacity of 4,000 private car units (PCU) per hour, and demand of 5,000 PCU per hour. Consider a project improving this section to three lanes and hence increasing its capacity to 6,000 PCU per hour. The elastic demand function for this case shows that under the extended capacity, demand increases to 5,269 PCU per hour. The project is now examined under both fixed demand and elastic demand methodologies and under different demand scenarios assuming a standard BPR volume delay function. The bias of the fixed demand methodology was measured as the difference (percentage) between the benefits calculated under the two methodologies.

Table 2 provides an example that calculates the bias in case of congestion. It shows that time saving for existing users is overestimated by 150 NIS (2,612 – 2,462), which is 5.7% under the fixed demand assumption (area *ghcf* in Figure 4). This is compensated by the additional benefits of new users of 66 NIS (2.5%, area *ahb* in Figure 4), resulting in an overall bias of 3%. Figure 5 shows the results for different congestion levels and three levels of demand elasticity: –0.25, –0.5, and –0.75. Results show that overestimates under fixed demand assumption are negligible under normal flow conditions but the bias is high under congestion conditions (V/C > 1) and elastic demand.

TABLE 2 Illustration of Fixed Demand Bias Under Congestion, Assuming Demand Elasticity of −0.25

		Case Study Congestion Condition	
	Unit	Without Project	With Project
Lanes		2	3
Capacity	pcu/h	4,000	6,000
Length	km	10	10
Free flow time	h	0.111	0.111
Benefits Under Fixed Demand			
Demand	pcu	5,000	5,000
V/C		1.25	0.83
Time	h/veh	0.15	0.119
Total time	h	759	596
Time savings	h		163
Total benefits	NIS		2,612
Benefits Under Elastic Demand			
Demand	pcu	5,000	5,269
New users	pcu		269
V/C		1.25	0.88
Time	h/veh	0.15	0.121
Total time	h	759	638
Benefits			
Existing users	NIS		2,462
New users	NIS		66
Total benefits	NIS		2,529
Bias Under Fixed Demand			
Total	NIS		84
Percent	%		3%

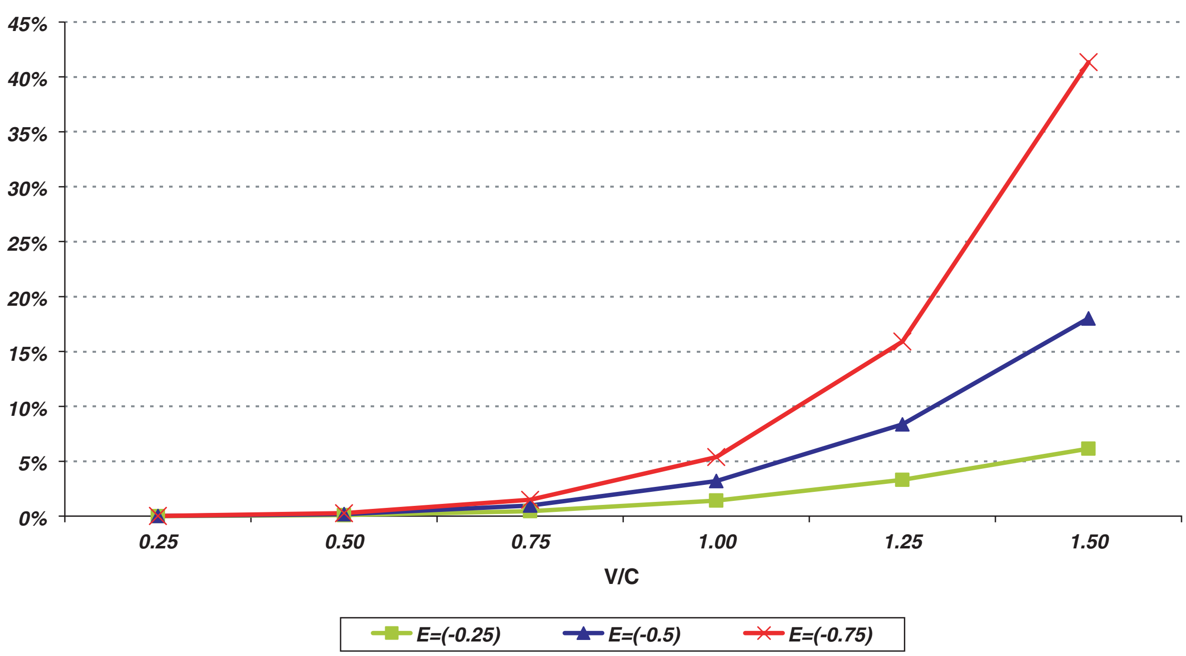

FIGURE 5 Fixed demand bias under different congestion scenarios (%) for three levels of demand elasticity.

SUMMARY AND FUTURE RESEARCH

There is a continuous need to improve project appraisal methodologies and values to fit today's transportation planning needs. The new 2006 Israeli guide is a result of substantial research and comprehensive review of worldwide developments, positioning project appraisal technique in line with best practice and state-of-the art transport economics.

This paper focuses on the main methodologies and changes introduced in the new guide. The main improvements include expanding categories of value of time and modifying them; a new safety procedure accounting for the fact that accidents' cost is a result of the probability of an accident and its severity, both of which are functions of traffic volume and speed; new environmental analysis; and equity analysis.

Special attention was devoted to analyzing the potential bias of benefits estimates under a fixed demand assumption, commonly used by most travel demand models. It was shown that benefits are usually overestimated by the use of the fixed demand assumption. These overestimates are negligible under normal flow conditions, but the bias is high under congestion conditions and elastic demand.

Israel is currently allocating significant budget to megatransportation projects such as the Jerusalem and Tel-Aviv light rail projects, bus rapid transit in Haifa, major extensions of the rail network, and expansion of the intercity highways system. The new appraisal framework is better capable of dealing with such complex projects as well as sustainable complementary policies. The new guide, thus, assists decision making and contributes to economic growth and social welfare.

Future research should focus on the impact of transport projects on economic growth and regional development; benefits from improving travel time reliability, including the effects of private financing of public infrastructure; more comprehensive risk analysis; system analysis of urban safety impacts; and incorporation of the new activity-based models into the evaluation procedure. Further research, which the authors are currently conducting, should also compare investments and decision making according to the old guide and the new guide and the new guide's contribution to sustainable transportation development.

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