A BREAKEVEN ANALYSIS FOR STATEWIDE ITS PROJECT
IDENTIFICATION AND ASSESSMENT

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Abstract

This paper discusses the use of breakeven analysis as a tool to assess the benefits of Intelligent Transportation Systems at the system level in system-wide sketch planning. The breakeven analysis was developed based on the SCRITS (SCReening for ITS) spreadsheet template and used data from Madison, Wisconsin as a case study. The break-even analysis provided considerable insight about the magnitude of the potential benefits of different ITS programs. It can help identify critical performance variables in the assessment of ITS benefits. Breakeven analysis coupled with sensitivity analysis can be used to identify and assess ITS projects for deployment in the ITS planning and programming process with limited data. The breakeven analysis can be used to screen, prioritize and select ITS projects among different ITS options. It can also be used to compare ITS project in different geographic locations based on different traffic data and breakeven points. The method is also useful in the identification of data needed for detailed ITS project assessments and evaluations. Such data should include before and after studies of ITS deployments as well as refined cost data and traffic flow estimates. The case study identified the break-even points of several ITS deployment options, including ramp metering, travel information systems, emergency response systems, and commercial vehicle operations under a variety of scenarios. These results can be used to identify and operate ITS projects so that they are likely to have the greatest payoff from their deployment.

INTRODUCTION

There is always a dilemma in ITS planning and programming, especially at the state level. On the one hand, we need data to determine the costs and benefits of different potential projects. On the other hand, costs-benefits analysis cannot be conducted without detailed data from implementation. Transportation professionals and decision makers have to make decisions on what projects to deploy and at which locations. These decisions have to be made with limited existing data. Based on very limited or even no data. The traditional costs-benefits analysis is very difficult to apply. There is no commonly accepted method and technique for project screening for program planning purpose yet. We developed breakeven analysis in this paper for statewide ITS planning and program screening with limited data before ITS projects are implemented.

This paper describes a break-even analysis that is used to identify the break-even points of a few ITS deployment options, including ramp metering, travel information systems, emergency response systems, and commercial vehicle operations. The results of these break-even analysis
can help state DOTs to assess and select ITS projects at the system level in the ITS planning process. This paper reports work being conducted for the Wisconsin Department of Transportation to measure ITS benefits. The opinions expressed are those of independent research and may not necessarily be those of the sponsoring agency.

**APPROACHES TO ITS BENEFITS ASSESSMENT**

There are two approaches toward the benefit assessment of ITS deployments, the goal-oriented approach and the economic analysis approach. The goal-oriented approach starts with defining goals and objectives, and setting up specific measurements. It focuses on whether the end product has achieved its original goals. The success or failure of a project is determined by comparing its outcome with the project goals. For example, if the goal is to reduce congestion and increase throughput on an expressway, and the project did reduce delay and improve traffic flow, the project is considered to be a success. Such an approach is likely to be used at the local or district level for project selection and identification.

The economic analysis approach focuses on cost efficient ways to achieve the goal. For instance, if the goal is to reduce congestion and increase throughput, the economic analysis approach would ask whether the investment in ITS to achieve that goal is economically beneficial, and how the rate of return on investment compares to that of other projects. This approach is more likely to be used at a statewide level for project selection.

**Goal Oriented Approach**

Many ITS evaluation frameworks and methodologies appeared in the recent literature used the goal-oriented approach (Richeson and Underwood, 1996; Rogova and Summers, 1996; Brand, 1994; Underwood and Gehring, 1994; and Turner and Stockton, 1999). Most ITS evaluation criteria and benefits analysis are based on the six national ITS goals proposed in the National ITS Program Plan (US DOT, 1995) developed jointly by the U.S. Department of Transportation (USDOT) and ITS America.

Based on the six goals, further evaluation measures are developed to quantify the evaluation of ITS projects. Because of the potentially large amount of evaluation measures that are related to these six ITS goals, the ITS Joint Program Office of the U.S. DOT advocates the use of so-called “a few good measures" that are “robust enough to represent the goals and objectives of the entire ITS program, yet few enough to be affordable in tracking the ITS program on a yearly basis” (FHWA, 1997). These “few good measures” include crashes, fatalities, travel time, throughput, user satisfaction or acceptance, and cost. Some ITS benefits can be identifiable by using specific measures and parameters, while others are more difficult to quantify.

A similar performance-based approach is used in the U.K (Tarry, 1996). Performance indicators that include value-for-money indicators, were developed in an evaluation framework to evaluate several ITS projects in the U.K, including the SCOOT adaptive signal control system in Aberdeen, dynamic message signs on the M40 in West Midlands, driver information system in Scotland, and accident reduction scheme in Yorkshire.
Economic Analysis Approach

The other approach for ITS evaluation uses economic analysis techniques similar to those used for highway project economic analyses. This approach attempts to quantify the specific monetary value of all ITS impacts. It focuses on quantifying the short- and long-term economic impacts of ITS projects on regional and national economies (i.e., employment, productivity, etc.), the users, the private sector, the community and the environment. This approach attempts to reduce everything to a single benefit-to-cost ratio (Zavergiu et al., 1996; Novak and McDonald, 1998; Lee et al, 1997, 1999).

Zavergiu et al. (1996) suggests that ITS evaluation should encompasses more than benefits accrued to transportation system users, it should also include transportation infrastructure providers and managers, potential private investors/ITS technology providers, and the community and the environment.

Novak and McDonald (1998) focus on the potential macroeconomic impacts of ITS investment in the U.S., including direct employment, economic multiplier, national productivity gains, technological spin-offs, and competitiveness. But the measure of these macroeconomic impacts was difficult because the core ITS infrastructure was not widely deployed in most metropolitan areas.

Lee et al (1997, 1999) also examines the economic value of various ITS projects. They have developed a spreadsheet model for conducting cost-benefit analysis of ITS projects. The spreadsheet model converts ITS impacts to monetary values by taking into consideration of both internal (user) benefits and external benefits.

Comprehensive benefit cost analysis is very tricky because of issues of double counting and proper valuation of benefits. In addition, most ITS projects include multiple components and it is difficult to disentangle the benefits of each component from the others. It can be useful if the differences between alternatives only occur on a few measures and if it is used to compare alternatives rather than to develop absolute values of benefits.

Both approaches have their limitations. Sometimes the goals of a project are not crystal clear or are themselves even conflict. On the other hand, many benefits are difficult to assign a monetary value, which makes economic analysis challenging. Both approaches are complementary and should be used together or in different situations depending on the scale and the time frame of the analysis.

The scale of the cost benefit analysis

An evaluation of ITS deployments can be conducted at the project level and system-wide level. A project evaluation focuses on the output of a specific project while a system level evaluation focuses on the impacts on the system as a whole and the overall outcome of the investment, whether that system is a metropolitan area or a state.

A project usually has very specific goals and objectives to start with. Therefore, it makes goal-oriented approach more appropriate at the project level. At the system level, the decision-makers are more interested in questions like how we should allocate funds that would offer us
higher overall returns given the fixed transportation budget. Therefore, at the system level, it may be more appropriate to use the economic analysis approach. Systems level evaluation will also have a different set of considerations from project level evaluations. Certain criteria used at the project level will not appear at the systems level since they cancel out over a large geographic area. The concept of a ‘zero sum game’ is relevant at the statewide or national level, but for project level analysis, there can be substantial differences (Beimborn, 1993).

**INTERRELATIONSHIPS BETWEEN BENEFITS**

Because transportation benefits can occur to different groups and organizations, it is useful to portray them using a benefit tree. The benefit tree indicates how a technology has effects on agencies, travelers, non-travelers, freight and transit carriers, and the general population at different levels, as well as how these levels are related. This technique is valuable in that it can eliminate double counting and illustrates non-monetary benefit components such as improved data, environmental considerations, pollution and goodwill.

The benefit trees helps to distinguish between the two basic types of evaluation measures that are commonly used in ITS evaluations: Internal impacts (or benefits) to the users and external (or system) impacts (or benefits) to non-users, to the economy and to the community (Lee, 1999). Internal impacts refer to direct benefits to the traveler at the individual traveler level, such as improved mobility and travel opportunities, less travel times and greater travel time reliability. Internal impacts typically characterize the effects of transportation on impacted groups. External impacts refer to indirect benefits to the transportation system as a whole (less congestion), to the environment (less air pollution), and to the economy (more productivity).

Separate benefit trees have been developed for each of three areas of ITS technology: traveler information systems, incident management systems and commercial vehicle operation systems.

**Traveler Information Systems**

Traveler information systems provide real-time information to travelers and commercial vehicles about the conditions of the transportation system. This information can include indications of the level of congestion, as well as special notices of incidents that affect the flow of traffic. Traveler Information Systems allow transit and automobile travelers to make smarter decisions regarding travel time, modes and destinations thereby saving time and having greater reliability in their travel.

The Traveler Information System benefit tree indicates four areas of impact: direct impacts on travelers and goods carriers, effects on non-traveler and freight customers, effects on transportation agencies and environmental effects as shown in Figure 1.

The availability of real-time traffic information can translate into timesaving and enhanced safety for highway users. Traveler information systems also provide travelers and goods carriers with better predictability of travel time. They could also allow users to avoid hazardous conditions that can lead to reductions in the number and severity of crashes.
Non-traveler and shippers also benefit from traveler information systems by having more predictable arrival times for their goods or persons they are expecting. This can be particularly important for shippers and manufacturers who use just-in-time inventory systems. Transportation agencies see benefits through the potential for reduced costs for facilities, operations and planning. Better traveler information systems can provide useful data for systems management and help shape a positive image for public agencies.

**Incident Management Systems**

Traffic incident management systems are useful in coordinating activities and reducing the duration of the time required for restoration of normal traffic on highways following incidents. It can also potentially reduce adverse environmental effects when incidents are averted or their effects are minimized. In cases of emergencies, proper management and coordination among the road agencies and transport management officials, will allow for timely detection, verification and location of the occurrence, allowing for dispatching of the appropriate emergency vehicle and personnel. Incident management has benefits to travelers, freight carriers, non-travelers, enforcement and operational agencies (Figure 2).

Victims of incidents benefit from incident management systems because of the reduced response time. This can lead to reduced severity of the results of a crash and quicker delivery of appropriate care. Other travelers and goods carriers benefit because of a shorter duration of congestion related to the incident. A quicker response time can lead to a reduced probability of becoming involved in a secondary incident and an increase of throughput.
Commercial Vehicle Operation Systems

Deployment of commercial vehicle operations systems has benefits that translate into reduced costs for vehicle operators, greater reliability for freight customers, savings for highway and enforcement agencies and some environmental effects. The potential benefits associated with commercial vehicle operations systems are shown in Figure 3.

Commercial vehicle operations can reduce paper work by electronic information sharing and automatic data collection, which can reduce the personnel need. Roadside electronic screening reduces wait time at weight stations and increases the reliability of goods delivery. This can lead...
to reduced inventory costs and increased productivity. Furthermore, commercial vehicle operation systems will increase the efficiency of enforcement agencies by reducing paperwork, and improving compliance with regulations. It can provide better information for future planning.

**BENEFIT ESTIMATION METHODS**

There is a suite of tools and methods that have been developed or are under development for ITS benefits estimation. These tools can generally be categorized into two groups. One group of tools provides add-ons to current transportation planning models, which needs detailed transportation planning database and travel information. These tools, developed by the Joint Program Office of ITS at the USDOT, include ITS Deployment Analysis System (IDAS), and the Process for Regional Understanding and Evaluation of Integrated ITS Networks (PRUEViNN). The Transportation and Analysis Simulation System (TRANSIMS) is also attempting to incorporate ITS elements in its simulation models. The other group is cost-benefit-based spreadsheet model at the sketch planning level, including SCReening for ITS (SCRITS) and an ITS evaluation spreadsheet model developed by the Volpe Transportation Center. The spreadsheet models are based on cost and benefit parameters and travel time savings to estimate cost and benefits of specific elements of ITS.

Since this paper concerns the sketch analysis for statewide ITS planning and programming, those add-ons to transportation planning models are not discussed here. In this project, we have adapted and expanded SCRITS (SCReening for ITS), a spreadsheet analysis tool, to do break even analysis of ITS options. It use is illustrated by using data from Madison, Wisconsin as a case study.

**A BREAKEVEN ANALYSIS OF THE BENEFITS OF ITS USING SCRITS**

True benefit cost analysis cannot be done in a specific location without detailed before and after data on the actual performance of a system. Break-even analysis and sensitivity analysis provides a method to determine the minimum level of performance necessary for a system to have a level of benefits that equal its costs. The purpose of the break-even analysis was to identify critical performance variables in the assessment of ITS benefits and to determine their relative magnitude for an acceptable benefit cost ratio. Such an analysis can be very useful since the results can be interpreted to see if they appear reasonable and possible to obtain. For example, if a ramp metering system requires a speed increase of 12 miles per hour to break even on a highway that operates at a peak hour speed of 50 mph, it would not be a reasonable alternative since the resulting speed would be in excess of the normal free flow speed on a urban highway. However, if a 2 mph increase were required to break even on a facility with operating speeds of 35 mph, it would be a very desirable alternative.

A breakeven analysis was conducted to estimate the benefits of ITS by adapting a spreadsheet model -- SCRITS. SCRITS has been developed to offer a range of benefit estimates for ITS applications for planning purposes at the system (state or metropolitan) level. It should be noted from the outset that the estimated output are approximate and should be used for general planning purposes only, because the tool SCRITS is intended to be a “first cut” at the estimation of benefits for planning-level assessment. Furthermore, the analysis focuses on user benefits at the system only. Benefits of ITS that accrue to agency operations (e.g. staff
efficiency, management effectiveness, etc.) are not considered, although these additional benefits to transportation agencies constitute some of the main reasons for implementing ITS. Thus, a narrative that describes the non-quantified elements of ITS benefits should accompany any analysis of ITS benefits.

There are 16 modules in SCRITS for 16 different ITS elements. This study concentrates on highway ITS applications, i.e., Ramp Metering, Freeway Detection Systems, Closed Circuit TV, Highway Advisory Radio, Variable Message Signs, Traffic Information Kiosks, Internet Traffic Information, CVO Kiosks, and Weigh in Motion Systems.

Breakeven Analysis Methodology

The process of doing a breakeven analysis is relatively straightforward. Essentially it involves solving benefit cost equations backwards assuming a benefit cost ratio of 1.0. Benefits are set equal to the annualized costs of an ITS element (e.g. ramp metering, CCTV) and the number is then divided by value of time and the number of operating days per year to get a daily benefit level. The resulting numbers are usually in terms of vehicle hours or daily crashes or some other indication of performance. These terms are converted to per vehicle terms and then to the specific performance parameters like speed and delays. For example, ramp-metering performances result from the net of time savings on the freeway because of higher speeds, minus delays at ramps and on arterials. The following equations were used:

\[
\text{Required daily vehicle hour savings} = \frac{\text{Annualized cost}}{\text{value of time} \times \text{operating days/yr}}
\]

\[
\text{Required freeway time savings/vehicle mile} = \frac{(\text{daily savings} - \text{arterial delay} - \text{ramp delay})/\text{freeway vmt during ramp operation}}{\text{freeway vmt during ramp operation}}
\]

\[
\text{Breakeven speed in mph} = \frac{60}{\text{freeway time savings/vehicle mile}}
\]

Use of breakeven analysis can identify critical performance measures which can be further used in the sensitivity analysis. Performance measures can then be varied to determine how they affect the breakeven points. For example, analysis can be conducted of the effect of traffic volume or value of time assumptions on the breakeven results. These analyses are very useful in defining data collection requirements and areas where further work is needed to get better data. The reverse is even more useful. Performance measures with low levels of sensitivity do not require extensive efforts to refine the numbers. Several examples of this type of analysis are given later in the paper.

Assumptions

General assumptions are made of various parameters to conduct the analysis. For the examples discussed in this paper, these are as follows:

Financial Assumptions:

- Discount rate - 5 %
- Value of time - $9.85 per vehicle hour.
$21.13 per truck vehicle hour

- Cost per accident - $15,000
- Reduction in crashes due to metering - 20%
- Weekdays per year - 250

Baseline Data and Traffic Assumptions

The baseline data for this analysis was derived from the design study report for a pilot ITS deployment project on the Madison Beltline in Dane County, Wisconsin, USA (HNTB Corporation and Transcor, 2000). This project envisions deployment of ramp meters, detection systems and traffic condition cameras along overlapping routes of USH 12/14/18/151 on the Madison beltway south of the city. The roadway section is twelve miles in length and the project will have five locations with ramp meters (four westbound and one eastbound), five locations with video cameras and 15 locations with roadway detection systems. These elements would be linked to a central facility for freeway monitoring and control.

Traffic levels were derived from WDOT traffic volume reports and the project design report. These were a daily VMT (vehicle miles of travel) of 1,204,000 for the freeway and 200,000 for adjacent arterials. It was also assumed that there was a 50/50 directional split in the traffic with 26% of the volume occurred in the westbound direction and 28% in the eastbound direction volumes occurring during the peak three hours each day for both the arterials and the freeway. Westbound ramp metering was applied to 33% of the westbound traffic (two of six interchanges metered) and to 20% of the eastbound traffic (one of five interchanges metered). SCRITS uses these numbers to determine the traffic affected by the metering. Affected VMT is the product of total VMT, directional split, peak percentage and ramp metering coverage. Freeway time savings and arterial delays were calculated based on the affected volume and the speed differentials as a result of metering. Average ramp volumes during the peak periods were 1600 vph westbound and 5500 vph eastbound. Ramp delays are applied to these volumes.

BREAK EVEN ANALYSIS RESULTS

Ramp Metering

Benefits from ramp metering are primarily based on accident reductions and the expected increase in speeds from ramp metering minus delays on parallel arterials and ramps. There are positive benefits if ramp metering saves freeway vehicle time that exceed the increased delays on arterials and ramps. Figure 4 indicates the time savings and delays by element types assuming a 10 mph increase in freeway speeds, a 4 mph decrease in arterial speeds and an average delay of 30 seconds per vehicle of ramp delay and a reduction in crashes of 20% for the Madison beltline example. The example shows that with these assumptions, the freeway timesavings exceed the arterial and ramp delays and that the project would have a large timesavings benefit with these values (Figure 4). The actual magnitudes of the numbers will vary considerably depending on assumptions made about the performance of the various elements.
The break-even analysis helps to provide insight into the circumstances that have a positive benefit cost performance. The level of the benefit cost ratio varies directly with the increase in freeway speeds as shown in Figure 5. The project breaks even when the speed increase is about 3.7 mph with the data used in this analysis. With this speed, the freeway timesavings are equal the delays on the ramps (30 sec per vehicle) and arterials (4 mph decrease in arterial speed).
Additional break-even analyses were done to determine combinations of speed changes and delay that are needed to cover the annualized costs of the ramp meter installation. Benefits were set equal to the annualized costs and the equations were solved backwards to find the required freeway speed increase for various combinations of ramp delay and arterial speed decreases. The results of this analysis are shown in Figure 6. Crash reductions were held constant for these examples.

In this situation, the required freeway speed increase varies somewhat with assumptions about arterial and ramp delays. A freeway speed increase of 0.9 mph is needed when there is zero delay on arterials and ramps in order to cover the annual costs of the metering. Beyond that there is a variation of about 3 mph between the extremes indicating that in this example, the ramp metering is not very sensitive to assumptions about operational delays. The break-even speeds are well below the expected gains from metering as reported in detailed CORSIM analysis as done by Strand Associates for the project (Strand Associates, 200). This indicates that the project will likely have substantial benefits if it results in even a small increase in freeway speeds.
Finally, a breakeven analysis was done between traffic volume and freeway speed increase. These results are shown in Figure 7 with various levels of ramp delay. As traffic volume increases, it requires less speed improvement on the highway to breakeven. The breakeven speed improvements also vary with the level of ramp delay. This analysis does not include the decrease in speeds that would also occur from a declining level of service that may result from increased volumes.

From this analysis, several conclusions can be drawn:

- Installation of a ramp metering system involves tradeoffs between increased freeway speed vs. delays on ramps and nearby arterials. Delays on ramps and arterials need to be offset by speed increases on the freeway itself and/or by crash reductions in order to have a positive benefit cost ratio.

- Key performance indicators for ramp metering systems are the speed increase on the freeway, average delay per vehicle on metered ramps and speed decrease on adjacent arterials, as well as freeway traffic volumes.
Methods for ITS Benefit Evaluation

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- Ramp metering is likely to have a significant benefit cost ratios in situations where freeways face peak hour congestion. Relatively small increases in freeway operating speeds (about 3.7 mph in the metered region for the case study) are necessary in order to have a positive benefit cost ratio. These increases remain small across a range of delay values for ramps and arterials. Based on the 20% to 30% speed improvement reported in Seattle, Minneapolis and other cities (Turner et al, 1998), the magnitudes of the increase shown in the case study should be attainable in most situations, especially when freeways operate at a poor level of service.

- In situations where freeway volume is relatively low but the entering ramp volumes are very high, ramp-metering systems may make less sense since ramp delays could be considerable as compared to gains in freeway performance.

Figure 7 Breakeven highway speed improvements for different traffic volume

![Break even Freeway speed increase vs traffic volume](image)

**Commercial Vehicle Operator Systems**

There are a variety of CVO systems. Our analysis considered weigh in motion systems. The benefits from timesavings and vehicle operating cost savings as a result of bypassing static scales are calculated. For this analysis data supplied with SCRITS was used. This was a single scale with 5000 vehicle per day usage and an average delay of 4 minutes per vehicle. The cost of the scale was assumed to be $200,000 with a 7-year life and an annual operating cost of $20,000.
per year. Vehicle operating cost was given as 30 cents per stop. Bypass rate, timesavings per stop and scale usage were varied in the break-even analysis with the results as shown in Figure 8.

As the chart shows, the break-even point is a relatively low number in nearly all cases. A minute or less time savings per bypassed vehicle can create benefits that easily covers the annual costs of a system with the data as used. The break-even point drops sharply with traffic volume at the scale and with higher bypass rates. It appears that a weigh in motion system that allows vehicles to bypass static scales is a good investment in nearly all cases except when the volume of vehicles that would use it is very low.

Figure 8. Weight in motion breakeven analysis

Traveler Information systems:

There are many options in traveler information systems. Some options relate to highway incident management, such as detection systems and CCTV video. Others are travel information dissemination methods, such as Highway Advisory Radio, Variable Message Signs, Pager or FM Sub carrier-based ATIS, Traffic Information Kiosks and Internet Traffic Information. SCRITS determines benefits on the basis of the reduction of incident duration and the number of affected motorists that use the information. Since each module of SCRITS is separate, results of the break-even analysis need to be carefully interpreted. If a combination of elements is used, their timesavings and incident duration reduction needs to be the sum of different components of the traveler information systems. SCRIPTS does not offer a way to calculate the cumulative benefits of different components.
CCTV

The Madison beltline project will have 5 camera locations and it was assumed that each camera could cover ¼ mile in each direction giving CCTV coverage of 19% of the roadway length. Although SCRITS calculates the emissions reductions from the system, these numbers are not used in their benefit/cost analysis. SCRITS uses a table look up process to determine a ratio of incident related delay to non-incident related delay as a function of peak hour traffic ratios and the presence of shoulders on the freeway. Reductions in vehicle operating costs are also included, and benefits are determined over an entire week, including weekends. The default lookup table from SCRITS was used in this analysis. The ratio of average, annual daily traffic to capacity was set to yield an average peak hour traffic speed of 45 mph. With these assumptions and the cost data as given earlier, the break-even results are shown in Figure 9.

Figure 9. Break even analysis for CCTV

The analysis indicates that relatively small reductions in incident duration are needed to provide a break-even benefit cost level. VMT on the case study is about 1,200,000 per day and this needs a reduction of about 34 seconds in incident duration to break even. A variation in traffic volume has an effect on the break-even point, but the required time savings are relatively small at all traffic levels. The traffic volume results should be viewed carefully since the AADT to capacity ratio is not changed with the lower traffic volumes.
Detection Systems

Analysis of the detection system is similar to that of the video system using the same set of assumptions and traffic data. The break-even results are shown in Figure 10. The break even numbers are about half of those of the CCTV system, because of lower annual costs. Like the CCTV, the magnitude of the break-even values is small. At the base VMT of about 1,200,000, only a 15 second reduction in incident duration is needed to have a benefit cost ratio of 1.0.

Figure 10. Breakeven analysis for the detection system

Highway advisory radio, pagers and Internet

For benefits to occur with these systems, drivers must be able to use this information to save time by taking alternative routes or otherwise changing their travel pattern. There is a strong relationship between benefits of such a system and the level of successful use and its ability to provide useful information as shown in the figure. If the system has only few persons who use it and receive useful information, the break-even timesavings have to be high. As the number of successful uses increases the break-even point drops rapidly. The break-even points for highway advisory radio, pagers and the Internet are shown in Figure 11. The break-even points for pagers are higher than the radio because of a shorter project life of the pager system. The break-even points are lower for the Internet information systems than for the other methods because of relatively low initial costs for web page setup and design.

This indicates that the highway advisory radio, pagers and the Internet information systems needs to be deployed in locations where there are high numbers of drivers, in situations where traffic conditions are highly variable, where there are good alternative routes available and in places where useful information can be supplied from other traveler information systems.
Summary of Breakeven Analysis of Traveler Information Systems

From the break-even analysis for traveler information systems, the following conclusions can be drawn.

- Systems that detect incidents of a highway such as CCTV and vehicle detection systems have very low breakeven values. Such systems need to reduce incident duration by a minute or less to have a benefit cost ratio of 1.0 or more over a wide range of traffic volumes. A small time reduction in responding and clearing an incident can lead to large benefits. Based on the observed response time reduction between 3 and 5 minutes reported in Atlanta and San Antonio (Turner et al., 1998), incident detection systems could have large benefits.

- The benefits of alternative means of providing traveler information (highway advisory radio, pagers, kiosks, internet and variable message signs) depend on the ability of users to make adjustments in their travel patterns as a result of the information and the number of users of each system. Systems that serve a large number of users at once such as pager, Internet, or highway advisory radio have advantages over kiosks, which can only serve a few users at once.

Figure 11. Breakeven analysis for traveler information systems

![Traveler Information System Break Even Analysis](image_url)
DISCUSSION

The benefits discussed in the break-even analysis are only a partial picture of what would occur if various ITS systems were deployed. The benefits are to the system as whole or external benefits and will vary for individual users. In some cases, external benefits at the system level may lead to internal benefits at the individual traveler level. For example, a good throughput may transfer to time saving for individual travelers. But in many other cases, an overall benefit may not lead to an individual’s internal benefits. For instance, ramp metering may lead to increased vehicle throughput along a freeway corridor, but it may lead to delays for ramp meter users, especially for short-distance commuters. Similarly, a good internal benefit for individual travelers may not lead to good external benefits either. For example, if most people get the same real time information and make the same decision either delay the trip or take an alternative route, that information may worsen traffic on the adjacent highways.

Users’ internal benefits of ITS are more difficult to measure than benefits at the system level. For example, a user of advanced traveler information system would find the real time traffic information before the trip very valuable, so he/she can save travel time by shifting start time. But the value of that traveler information system will vary depending on the user and the user’s travel behavior changes. If the traveler decides on changing route, the internal benefits can be directly measured using the attribute changes (e.g., time savings) (Lee and Klein, 1997). But if the user decides to go ahead with the trip anyway or change travel destination, using time saving could become problematic. If the user decides to go ahead with the trip, he/she could be psychologically more prepared. In this case, a congested travel becomes a “serene” travel (Lee, 1999) even though the travel time does not change, or the traveler can inform the other party about his/her travel status so that other party is more prepared. If the user decides to change travel destination, direct comparison of travel time saving is difficult. To properly measure the value the traveler put on the advanced traveler information system from an economic sense requires the direct measure of consumer surplus, which requires a stated preference survey to elicit dollar value to reflect the consumer’s willing-to-pay.

CONCLUSIONS

This study shows that simple spreadsheet methods such as SCRITS when supplemented with break-even and sensitivity analysis can be adapted to provide screening tools for ITS project assessment with limited data requirements. In particular break-even analysis offers a method to screening promising ITS projects and provides considerable insight into the sources of benefits for ITS components. The break-even analysis can be used to screen, prioritize and select ITS projects among different ITS options. It can also be used to compare ITS project in different geographic locations based on different traffic data and breakeven points. Some of the key findings from the break-even analyses are as follows:

- ITS systems can be more logically selected and deployed when knowledge of their performance tradeoffs are known.

- ITS systems can have large benefits, which easily exceed their costs. These benefits are especially likely to occur if the existing level of performance of the highway is poor.
• Other effects such as increased peace of mind, crash reduction greater reliability in arrival times, non-traveler benefits, agency benefits and environmental benefits cannot be easily quantified but would add to the benefits of an ITS.

• Ramp metering systems benefits depend on tradeoffs between increased freeway speeds with metering vs. ramp delays and arterial speed decreases. Ramp metering projects should be concentrated on places where the level of performance of a highway facility is poor and ramp volumes are moderate.

• Weigh in motion systems appear to have a positive net benefit even with small levels of usage.

• Incident management systems should be implemented in a way to minimize incident duration. This is an area of very high potential benefits. Incident detection and traveler information systems should be concentrated on locations where there is significant incident-related delay and where alternative routes are available. Internet information systems and highway advisory radio appear to have a good likelihood of favorable benefit cost ratios with even low levels of utilization because their low costs.

It should be noted that the breakeven analysis using SCRITS was done with limited data and it has potential as a tool for project identification and sketch planning. The inputs to SCRITS should be carefully scrutinized prior to its widespread use as a screening and benefits assessment tool for ITS projects. Such data should include before and after studies of ITS deployments as well as refined cost data and traffic flow estimates. One may need an extremely sophisticated evaluation framework and need very detailed data to determine the true economic impact to society. Whatever method is used, it should be accompanied by extensive sensitivity and breakeven analysis to determine the importance and robustness of specific assumptions in the determination of benefits.

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