NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM REPORT 189

QUANTIFYING THE BENEFITS OF SEPARATING PEDESTRIANS AND VEHICLES

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL

Exhibit B

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QUANTIFYING THE BENEFITS OF SEPARATING PEDESTRIANS AND VEHICLES

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AREAS OF INTEREST:
- HIGHWAY SAFETY
- ROAD USER CHARACTERISTICS
- URBAN TRANSPORTATION SYSTEMS

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

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The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

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FOREWORD

By Staff
Transportation
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This report contains a comprehensive methodology for evaluating the social, environmental, and economic impacts of proposals for pedestrian facilities and will be of special interest to urban and transportation planners, and traffic safety specialists in state and local governments. Measurement techniques were developed for 36 variables that quantify all significant direct and indirect benefits of facilities separating pedestrians and vehicles. The methodology can be used to evaluate alternative facilities being considered for a single site or to establish warrants or priorities for a number of pedestrian facilities. The report is organized in easily identifiable elements to serve the needs of both practitioners and researchers. Practitioners will find the user's guide particularly helpful. It describes applications of the methodology and presents step-by-step instructions to use the measurement techniques recommended for each of the 36 facility evaluation variables. Researchers will find that this research builds firmly on previously established plan evaluation methodologies. Because the benefits of a pedestrian separation are influenced strongly by facility design, structural engineers and architects will find the report to be of interest. The research described in this report is related to the Federal Highway Administration's FCP Project 1-E, "Safety of Pedestrians and Abutting Property Occupants." More specifically, the research is closely related to and enhances the results of the work reported in FHWA's Research and Development Report No. 75-7, "A Comparison of Costs and Benefits of Facilities for Pedestrians."

In recent decades, the pedestrian has not been given adequate consideration in the decisions for person mobility. Increasing concern for the environment, safety, energy, community cohesion, and health have contributed to a social awareness of the pedestrian. In determining use of space, an inherent conflict exists between vehicles and pedestrians. This research has been directed to the need of identifying and measuring benefits of separating pedestrians and vehicular traffic.

The Stanford Research Institute approach to the problem, after evaluating the state of the art, was to identify benefits of separating pedestrians and vehicles and affected population groups. Hundreds of individual parameters were examined as candidates for describing benefits. At the same time, an intensive effort was begun to develop measurement techniques to quantify benefits. A goal in the development of the measurement techniques was to go one level deeper in precision than had been previously attempted by others. The results from these tasks were then incorporated into a comprehensive evaluation methodology that could be used to assess individual and alternative proposals for pedestrian separation facilities.

The methodology selected and described in this report is a scoring, rating, or matrix method, in which all relevant attributes of a pedestrian facility are assigned unitless scores over a designated range (through specified objective measurement techniques) and the scores are weighted and summed to a total. If it is a necessity to convert unitless scores to dollar values, guidance is given. The developed method thus combines subjective values that reflect community preferences with objective measurements for each variable under consideration. Possibly the greatest advantage of the recommended methodology is that it allows and encourages the use of many benefit measures usually excluded from conventional economic analysis. By reflecting community needs and values that are not easily quantified, use of the methodology may provide adequate justification for projects not defendable previously by economic analysis alone.

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The research reported herein was performed under NCHRP Project 20-10 by Stanford Research Institute, Menlo Park, Calif. Ronald L. Braun, Operations Analyst, and Marc F. Roddin, Transportation Analyst, were co-principal investigators responsible for performance of all of the research.

Dr. Joseph E. Armstrong and David A. Curry, Senior Policy Analysts, helped develop the evaluation methodology as well as quantification and description of some of the variables. Both performed extensive reviews of the draft material. Other persons who provided inputs to the measurement techniques were Kristin M. Clark, Research Analyst; Cynthia A. Kroll, Operations Analyst; Marilyn Duffey-Armstrong (formerly Bagley), Operations Analyst; Eleanor L. Myers, Research Analyst; and Edward P. Meko II, Transportation Economist. Judith Roberts (formerly Higgins), Transportation Analyst, worked on the benefits of separation and affected groups.

William A. Blandin, Traffic Design Engineer, Seattle (Wash.) Department of Engineering, provided sources of information for evaluating pedestrian facilities in Seattle. Lorne L. Smith, Chairman, Pedestrian Mall Authority of Ottawa (Ont.), provided valuable information and insights to the design and operation of the Sparks Street Mall. Jeannine M. Kahan, Director of Transportation Planning, Office of Downtown Brooklyn Development (now Transportation Supervisor, City of Belmont, Calif.), and her successor, Nazir A. Mir, Transportation Planner, provided plans and information sources on the proposed Fulton Mall.

QUANTIFYINC THE BENEFITS OF SEPARATING PEDESTRIANS AND VEHICLES

SUMMARY

A comprehensive methodology for evaluating the social, environmental, and economic benefits of proposals for facilities separating pedestrians and vehicles was developed and demonstrated during the course of NCHRP Project 20-10. This report presents the analyses undertaken as a part of the project, and the findings and recommendations of the researchers.

In the past, evaluation methods for pedestrian facilities, like those of other transportation projects, were based largely on a comparison of economic benefits and design, construction, and maintenance costs. Today, however, increased awareness of the automobile's responsibility for depletion of natural resources and spreading concern for health, safety, the quality of life, and the environment are providing the basis for a pedestrian renaissance—a return to pedestrian scale in the planning and design of facilities for people.

Accompanying the need for pedestrianization is the need for an evaluation methodology that can systematically measure the many diverse impacts of planned pedestrian facilities. The objective of this research was to identify and develop techniques for quantifying all of the significant direct and indirect benefits associated with the separation of pedestrians and vehicles, and to develop a methodology for relating these benefits to the evaluation of proposals for separation. Key research findings are summarized in the following.

Identification of Benefits and Affected Population Groups

The SRI project staff conducted an extensive review of transportation literature and articles selected from relevant social, environmental, health, and economic research areas, and held numerous discussions with experts in those areas. The objectives and results were to:

- Identify and characterize the population groups that are directly or indirectly affected by pedestrian-vehicular separation. Impacted pedestrian groups examined include: elderly, handicapped, children, persons under the influence of alcohol, shoppers, workers on break, persons conducting business, commuters, tourists, and strollers. Other affected groups include: joggers, bicyclists, motor vehicle operators and passengers, property owners, business persons, neighborhood residents, taxpayers, special interest groups (such as environmentalists), and political representatives at all levels of government.
- Identify and describe all significant direct and indirect benefits of separating pedestrians and vehicle traffic. A three-level hierarchy of items was developed by a lengthy iterative process that continued throughout the project. The benefits are listed in four major categories (see Fig. 1), as follows:

1. *Transportation*—includes the transportation impacts on actual and potential users of all transportation facilities within the evaluation area (pedestrians, motorists, transit riders, and others).

2. *Safety/Environment/Health*—includes the safety and health impacts caused by the construction and use of the facilities under study on all persons within the evaluation area (both users and nonusers), as well as the impact of this subset of factors on the physical environment.

3. *Residential/Business*—includes the impacts on interpersonal relationships, property, and attitudes of those persons within the evaluation area, also the impacts on industrial and commercial properties, and transactions within the evaluation area, as a result of the facilities under study.

4. *Government/Institutional*—includes the impacts of the facility under study on government and community-wide services and activities within the evaluation area.

At the second level are groups such as pedestrians, motor vehicles, and other community transportation. The third-level items, called "variables," are the major focus of benefit measurements. For example, the variables for the pedestrians group are travel time (1.1.1), ease of walking (1.1.2), convenience (1.1.3), and special provisions (1.1.4). A scoring procedure has been developed for each of the 36 variables identified during this project. These measurement techniques are presented in Appendix A and sample applications are given in Appendix B.

Suggested Evaluated Methodology

The research objective was to develop a comprehensive evaluation methodology that could be used to assess individual and alternative proposals for pedestrian separation facilities. The method developed is a unitless scoring system that combines subjective values reflecting community preferences with objective measurements for each of the 36 variables. Measured variable scores are weighted by preference or relative importance multipliers before the resulting relative benefit values for each variable are incorporated into a total score for each facility. This combination provides much more than just a "score" for a proposed facility, because the weighted variable scores provide considerable insight both on the values of the decision-makers, and on the attributes of the facilities themselves. This added information suupports a careful comparison of alternative proposals by identifying the important differences between alternatives. Chapter Two contains a detailed description of the characteristics of the evaluation methodology developed during this research.

Because many of the variables are subjective in nature (e.g., comfort, attractiveness, noise), the measurement of benefits is performed using a unitless scale of positive and negative values (+10 to −10) for each variable. Positive values correspond to desirable characteristics; negative values indicate undesirable characteristics. Zero values indicate either "does not apply" or "indifference" (neither good nor bad).

Unitless scoring reduces the need for assigning dollar values to the many noneconomic impacts of pedestrian facilities (and many other public projects). Such scoring is particularly appropriate to the stated project objective because comparison of alternatives can be performed by comparing unitless scores and costs without the need for calculating benefits in dollars. Guidance is also provided for obtaining benefit values in dollars, if required, to allow comparison of pedestrian facilities with other public projects.

The difficulties associated with the development of community preferences have been partially alleviated by provision of suggested weights for each variable. The researchers devoted considerable effort to discussions with planners, analysts, designers, evaluators, decision-makers, and pedestrians to obtain information about their needs and desires, their likes and their dislikes concerning pedestrian environments. A questionnaire (App. C) was also distributed to a similar but larger group of planners and decision-makers to obtain their relative preference values for each of the evaluation variables.

Different sets of weights may be appropriate for different types of pedestrian facilities, depending on the major purpose of the facility. The safety/movement type includes those facilities where severe pedestrian/vehicle conflicts occur or where high pedestrian volumes result in congestion, and the primary intent is to provide safe unimpeded pedestrian movement. The social/commercial type includes planned activity pedestrianization where the major purpose is to provide a safe and enjoyable place for pedestrians to move leisurely and linger, or to shop. Overpasses and pedestrian transit ways are examples of the first type; malls and small urban parks are examples of the second type.

When the questionnaire was distributed, respondents were requested to identify which type of facility they were considering, or if both types were being considered together (combined facilities). Comparison of the questionnaire returns indicated that few significant differences existed between combined facilities and safety/movement facilities. Thus, a single set of weights (or community preferences) can be developed for either safety or combined facilities.

However, the questionnaire responses for social/commercial-oriented facilities were significantly different from both safety only and the combined weights. Discussions with other planners indicated similar differences. Thus, a special set of weights may be appropriate when social/commercial objectives are the primary basis for pedestrian facilities in a community. The researchers have developed two sets of suggested weights for evaluators to use as a starting point in developing their own weights (presented in Chapter Three).

Measurement Techniques

The original research plan was to identify the best state-of-the-art techniques available for measuring the social, economic, and environmental impacts of transportation projects; to identify the deficiencies in applying these techniques to pedestrian facilities; and to improve on them as much as needed. Careful examination of relevant literature revealed that no measurement techniques were available for many of the impacts the research was intended to cover. Thus, what was anticipated to be a moderate effort in this area became the major focus of the research. The results of the extensive research and development effort on measurement techniques are given in Appendix A.

As the focal point of this research project, great care was taken in the selection of evaluation variables and in the development of specific measurement techniques for each variable. The key criteria for inclusion were:

- Did the item represent a potentially significant impact of separate pedestrian facilities?
- Was the item well enough defined so it would not be included more than once (double counted) in the measurement process?

In addition to informal discussions on possible measurement techniques with specialists in each of the impact areas, two general review meetings were held with an aesthetics expert, an environmental planner, an urban planner, a noise expert, a transportation economist, and several transportation planners. These meetings were structured to critically review the grouping, order, and content of the individual impact items under consideration. The first general meeting was held before the measurement techniques were fully developed. The second was held after their development to reassess the original selection and consider information added by the field evaluations.

A scoring system for each of the selected 36 variables was developed by using several basic techniques. They include selection of values from tables, simple formulas, summed table values, separately scored components, weighted formulas, and qualitative scoring (each described in Chapter Two).

Several important criteria were used to guide the selection of a measurement type for each variable or component. The first was to choose the measurement type that provided the most precise degree of quantification consistent with the data and information available for the item under consideration. The second criterion was a deliberate attempt to measure at least one level deeper in precision than had been previously attempted by others. This criterion was adopted to encourage serious consideration by evaluators and others on the meaning and importance of all of the variables. It resulted in inclusion of hundreds of individual parameters as components or characteristics of the 36 measurement variables. The third criterion was an attempt to estimate the relative importance of components within variables, especially where the literature or discussions between the researchers and others indicated probable unequal weighting.

Since many of the measurement techniques developed during this research extend beyond the usual level of quantification for the selected variables, changes based on experience and future research will be required. Users of this research are encouraged to make changes to specific measurement techniques whenever such changes seem appropriate. When somewhat different values seem more appropriate to particular groups of evaluators or decision-makers, they should be used. A primary objective in the development of measurement techniques has been to develop a flexible, quantitative framework for examining and evaluating the many potential impacts of pedestrian facilities. Thus, the basic techniques can be used even if specific values for individual variables or components change over time.

Testing the Developed Techniques

Two existing and two planned facilities were chosen as test sites to provide a more complete testing of the developed techniques than had been scheduled originally. Two small-scale facilities were analyzed—a planned overpass at a hazardous intersection (Rainier Ave. and Empire Way) and a bridge closure to motor vehicles (20th Ave. N.E./Ravenna Park), both in Seattle, Wash. The successful Sparks Street Mall in Ottawa, Ont., and the proposed Fulton Mall in New York City's Borough of Brooklyn were chosen to test the application of the methodology to large-scale facilities.

The site selection procedure and data collection techniques used are described in Chapter Two. Detailed field test data for each of the four sites are given in Appendix B. The conduct of the field tests demonstrated the practical use of the developed measurement techniques. In addition, the tests provided valuable insights that suggested several significant revisions to both the measurement techniques and the over-all evaluation methodology.

Conclusion

The over-all methodology and the extensive range of measured parameters provide a broad perspective on the design and use of pedestrian facilities. Possibly the greatest advantage of the suggested methodology is that it makes possible and encourages the use of many benefit measures usually excluded from conventional economic analysis. By reflecting social needs and values that are not easily quantified, the use of the method may provide adequate justification for projects previously not defendable using only economic analysis. Thus, the general direction of the methodology is to increase the number of impacts considered by the decision-maker, while making the decision task easier by use of explicit rather than implied evaluation factors.

CHAPTER ONE

INTRODUCTION AND RESEARCH APPROACH

NEED FOR PEDESTRIAN/VEHICULAR SEPARATION

Concern for Pedestrians

Transportation considerations are an integral part of space planning and utilization. The range of these considerations is from the location of cities conveniently near access modes, such as rivers and highways, to the floor plan of a home that is organized around the expected traffic flow of the occupants.

Ancient and medieval planners took transportation factors into account by providing extensive pedestrian facilities within their cities because the primary transportation mode was walking. Some planners even separated pedestrian and vehicular traffic by decree, or provided barriers or grade separation. Many cities were provided with central pedestrian plazas to complement the important buildings located around the perimeter. These plazas provided a marketplace, a meeting and recreational place, and a safe haven from vehicular traffic. Pedestrian comfort was also accommodated by medieval planners through galleries, canopies, and other protective features used to shield pedestrians from the sun and inclement weather.

Gradually increasing volumes and speed of vehicular transportation have resulted in a complete reversal of those planning objectives. Pedestrians have been thrust into the background as ever-increasing vehicular demands continue. Vehicular transportation advanced in speed and flexibility too quickly to be concerned with its liabilities.

Today, however, an opportunity exists to restore the balance betwen vehicles and pedestrians within the transportation system. A significant number of coincident factors combine to refocus our attention on the feasibility of separating pedestrians and vehicles. Among these factors are:

1. *Transportation.* Increased understanding of the transportation needs of the elderly and the handicapped has led to examination of the need for better pedestrian facilities. The need for separation comes largely from transportation and safety aspects of the inherent conflict between vehicles and pedestrians. When conflict occurs, the vehicle driver is generally only aware of time and space, whereas the pedestrian is usually vividly aware of time, space, distance, comfort, and safety. The transportation needs of pedestrians are being recognized by a large number of cities and counties for the first time with the formulation of comprehensive pedestrian plans and bikeway systems. Many medium-size cities now have a full-time pedestrian/bicycle person on their planning staffs.

2. *Safety.* Reduction of the pedestrian accident toll, which amounted to 19 percent of all motor vehicle fatalities and 17 percent of all motor vehicle disabling injuries in 1974 (*Accident Facts,* 1975), is a national problem that is now treated at the local level with varying degrees of concern and results. There are also significant differences in pedestrian and traffic laws and in signing practices that result in confusion and accidents for a mobile population. Pedestrian-vehicle separation is obviously a way of eliminating the accident problem by eliminating conflicts.

3. *Social.* An increased awareness of the value of walking as a method of transportation is engendered by a wide variety of social factors. Indeed, the Office of the Secretary of the U.S. Department of Transportation is sponsoring research on incentives for nonmotorized utilitarian travel in urban areas. This is to be based on interviews with bicyclists, pedestrians, motorists, planners, policy-makers, and researchers, as well as an inventory of existing physical facilities and social programs in several cities. Attempts are being made to remedy the frustration to pedestrians

who are inconvenienced or prevented from performing their usual activities. Other social factors leading to increases in walking patterns are (1) a desire to slow down the pace of life; (2) emphasis on the "body beautiful" and the health and exercise effects of walking; and (3) the lessons brought home by the "energy crises" that motor vehicle transportation demands can be reduced, better managed, or directed to alternate modes.

4. *Environmental.* Concern for environmental factors is an integral aspect of many of the problems facing modern man. Motor vehicles are the worst offenders in causing the poor air quality in our largest cities, with resultant harmful effects on man and his world. A possible effect of increasing the availability of useful pedestrian facilities will be a reduction in vehicle-miles traveled, especially in crowded urban areas. Even without a reduction in vehicle-miles traveled, a reduction in atmospheric pollutants can be achieved as a result of separate pedestrian facilities by a decrease in vehicle travel times due to fewer stops or increased average speeds. Another environmental factor is the depletion of nonreplaceable resources, such as fossil fuels. Replacement of vehicle use by walking is very helpful environmentally because short trips are the least efficient operating mode for automobiles.

5. *Health.* Several health factors are associated with separated pedestrian and vehicle facilities. The factors vary in significance depending on (1) the distance between vehicles and pedestrians, (2) whether the separation is horizontal or vertical (allowing pollutants to act on pedestrians above the roadway), and (3) the degree of isolation (e.g., one or the other in ventilated enclosures). These health factors include low-level carbon monoxide poisoning, noise and vibration that affect some individuals, physiological difficulty for elderly persons in obtaining medical services without adequate pedestrian facilities, exposure to inclement weather (including water splashed by vehicles), plus the effects of accidents involving vehicles. The exericse of walking not only contributes to general physical health, but has become both a preventive and remedial treatment for heart attacks.

6. *Economic.* The uneasy mix of vehicles and pedestrians on unseparated facilities provides only one assumed benefit; i.e., lower first cost in property acquisition and construction costs. Provision of safe, convenient facilities for pedestrians can reduce accident costs, reduce vehicle operation costs, increase retail sales adjacent to such facilities, and increase participation in community activities.

Characterization of Pedestrian Facilities

Pedestrian Networks

Pedestrian activity can be characterized as the nonmechanical movement of a person on a path from one activity location to another activity location. Each activity location can be considered as a terminator and originator of movement. It is obvious that literally any point could be such a location (e.g., "I will meet you at the middle of the block.").

To preserve the useful distinction between activity locations and paths, locations are used herein to refer to easily recognizable features such as homes; buildings (offices, stores, restaurants, museums, and the like); transit stops; parking areas; collection and distribution features (elevators, stairs, ramps, escalators, etc.); and distinct pathway intersections. As implied by the foregoing, the size or capacity of a location may vary depending on the intended application.

Pathways are subject to greater variation. They range from well-defined (a sidewalk) to directionless (such as a pedestrian mall or plaza), with many types between (the edge of the roadway or a trodden path through a field). The primary concern of this study is those pathways (also pedways or walkways) that incur construction or maintenance costs.

Consideration of pedestrian-vehicle separation suggests two basic types of pedestrian pathways:

- Pedestrian-exclusive—where vehicles are not normally allowed.
- Mixed—where vehicels are allowed to intersect or parallel the pedestrian pathway in the same time period, creating conflict opportunities.

The preceding section on the need for pedestrian-exclusive facilities described the types of factors to be considered in evaluation of these facilities. The following description identifies some of the features that a well-designed pedestrian facility should provide to the user of the facility.

Pedestrian paths should offer the pedestrian directness that will avoid time loss or greater distance. The paths should provide continuity of movement and possess adequate capacity. Vertical change requirements should be minimized. Protection against wind, rain, cold, heat, and pollution will enhance utilization, as will provision of security against criminal threat. Separation of pedestrians and vehicles will eliminate conflicts and provide safe pedestrian routes if access by pedestrians to vehicle pathways is prevented. The pathways should provide directional orientation and adequate accessibility. Finally, the pathway should offer a pleasing environment to stimulate pedestrian interest and psychologically reduce the negative effects of trip distance and duration.

In summary, pedestrian-exclusive systems can provide the benefits described in the previous section, plus advantages to vehicular traffic by the elimination of competition for time and space inherent in the mixed system. On the other hand, the mixed system may be characterized as a time-and-space conflict in the minds of vehicle operators; and a time, space, distance, comfort, and safety conflict in the minds of pedestrians.

Pedestrian-Exclusive Facility Types

A pedestrian-exclusive system may be composed of three types of separation features relative to vehicle location:

- Vertical or grade separation.
- Horizontal separation.
- Temporal separation.

Any or all of these features may be present in a pedestrian network, although the first two are frequently used for new pedestrian facilities, whereas temporal separation is commonly used with existing systems (e.g., intersection signalization and part-time "street-malls").

Vertical separation is frequently described as above-grade, at-grade, or below-grade, depending on pedestrian location with respect to ground level. This characterization is useful because of its cost implications and for feature identification. The advantages of at-grade pedestrian locations with below-grade vehicles are similar to those for pedestrian above-grade vertical separations in the discussions that follow, whereas overhead vehicle pathways result in a situation somewhat similar to below-grade pedestrian facilities by creating a tunnel effect for the at-grade pedestrians.

Some general advantages of below-grade systems are: protection is provided from sun and inclement weather, a free-form grid pattern may be used, the urban landscape is not obstructed, incremental expansion is possible, they can be linked to existing underground systems, direct linkage is possible between major activity centers, and vehicular circulation is improved.

The disadvantages of below-grade systems are: high construction costs, the requirements for change in grade and numerous entry points, adverse effects on orientation and coherence because of (a) loss of visual contact with the city and (b) imposition of an artificially created environment, and impeded emergency servicing.

Above-grade elements support pedestrian movement above the level of vehicular traffic. They may be characterized as:

- Independent—structurally self-supporting.
- Integral exterior—structurally integral with a building, but exterior to the building itself.
- Integral interior—structurally integral with a building or group of buildings in a development.

Above-grade systems can provide direct, convenient paths for pedestrians; a visually pleasing vantage point; elevated direct linkage between major activity centers; possible incremental expansion; more compact and efficient arrangement of retailing space; and improved vehicular circulation. Some general disadvantages of above-grade systems are: high construction costs, requirements for change in grade and numerous entry points, possible decrease in retail activity at the street level, additional visual clutter, and impeded emergency servicing.

Horizontal separations can be characterized as parallel (adjacent to vehicular movement) or displaced (physically separated from roadways by significant distances or other structures). Examples of parallel separations are sidewalks, arcades, and partial malls (sometimes with limited traffic). Examples of displaced separations are full malls and displaced grids (e.g., pathways between buildings) exclusive of vehicular traffic.

Parallel horizontal separation may provide a buffer zone with reduced potential for conflict and accident. However, such separations may reduce the street width available to vehicles, may increase vehicle congestion on surrounding streets, do not solve the problem of conflict at intersections, may not affect pedestrian exposure to weather, and may reduce retail store space.

Displaced horizontal separations, which are a better solution from the pedestrian viewpoint, can be developed in stages, allow a wide range of activities, and can be integrated with existing parks, malls, and plazas to create a system of urban open space. They also stimulate retail activity in immediate areas; provide freedom from noise and fumes; and may provide shelter. They also require total cooperation of property owners and other retail interests. Disadvantages of displaced horizontal separations are typified by high development, operating, and maintenance costs; comprehensive preplanning; increased traffic volumes on surrounding streets; and reduced retail activity on nearby streets.

NEED FOR COMPREHENSIVE EVALUATION METHODOLOGY

To view the state of the art of evaluation methodologies for pedestrian facilities from a broader perspective than would be possible otherwise, it is compared with a capsule history of highway project evaluations. Since about 1920, data and methodologies have been available for rational comparison of alternative highway location and design proposals on the basis of savings to users (travel time, accident avoidance, and operating cost savings to motor vehicle operators) compared with the highway construction, maintenance, and operating costs. Most highway evaluations performed at that time, however, were done by academics and researchers—not by highway decision-makers or their staffs. All too many highway projects were selected and constructed using engineering and travel demand inputs only, with merely a casual glance in the direction of economics. Over the last 25 or 30 years, most major intercity and urban highways have been completed; new investments are in reconstruction and improvement rather than in new facilities.

Decisions to implement such highway improvements have been subject to increasing public scrutiny and hostility, which has been facilitated by recent legislation, including the Clean Air Act, the National Environmental Policy Act, and the Federal-Aid Highway Act. In addition, the Federal-Aid Highway Act of 1973 made available funds for development and improvement of pedestrian walkways and bikeways located on or in conjunction with highway rights-of-way. These funds can be used to finance the federal share of the cost of constructing pedestrian walkways. No motorized vehicle would be permitted on these walkways except for maintenance purposes. Also under the provisions of that Act, the Federal Highway Administration can authorize states to use their regularly apportioned federal-aid highway funds for construction of pedestrian walkways outside the normal federal-aid highway rights-of-way and for planning and construction of auto-restricted zones in central business districts.

The Clean Air Act legislated air quality standards and emission controls. Its indirect source regulations apply to motor-vehicle-oriented facilities which do not themselves pollute, but which attract automobiles (e.g., athletic arenas, shopping centers, parking lots). The National Environmental Policy Act requires public disclosure of the impacts from federally funded projects; this requirement is usually satisfied with preparation of an environmental statement. Section 136(b) of the Federal-Aid Highway Act of 1970 requires transportation planning agencies receiving federal funds to develop an Action Plan that thoroughly considers all possible social, economic, and environmental effects of alternative courses of action throughout the entire project development process. This plan must be introduced into the study process as early as is feasible.

To satisfy the needs of these legislative requirements to ameliorate the adverse ecological and social impacts of new highway projects, particularly in dense urban areas, one viable alternative is installation of pedestrian-oriented facilities. This is one part of a move to achieve higher densities of land use and a decreased dependence on the automobile for personal intracity travel. Major shifts from automobiles to transit, bicycle, and pedestrian modes will result in less noise and air pollution, as reported in environmental impact statements. Ironically, though, in their rush to construct new pedestrian facilities in cities, many planners have neglected to assess the total impacts of these proposals. Instead, they assumed that any transportation facility designed primarily for pedestrians must be good because it will attract people away from other more polluting modes.

There is need for a systematic method of analyzing all of the impacts of a pedestrian-oriented facility. Analogous to the decisions made during the 1930s and 1940s to proceed with specific highway projects without an assessment of all of the project's outcomes, pedestrian facilities—such as malls and overpasses—are being proposed with little or no background study on pedestrian travel demand and travel time, motor vehicle costs, accident frequency, vandalism, retail sales, or a host of other variables.

In the event that more facilities have been proposed than can be funded or alternative proposals have been suggested for the same location, a choice must be made; this decision should be based on a rational determination of the impacts of the planned projects. In particular, the methodology should highlight all of the critical issues associated with the project, so that an informed decision may be made by the body politic.

OBJECTIVE AND SCOPE

The objective of this research has been to identify and develop techniques for quantifying all of the benefits associated with separation of pedestrians and vehicles, and to develop a methodology for relating these benefits to the evaluation of proposals for separation. The scope includes identification of the direct and indirect benefits of separation by: (1) considering transportation, safety, social, economic, environmental, and health factors; (2) identifying specific population segments in the community likely to benefit from or be affected by pedestrian-vehicular separation; (3) adopting or developing techniques for measurement of these impacts qualitatively, quantitatively, or in dollar values for use in evaluation and design of proposals for separation; (4) testing the developed techniques on two planned and two existing pedestrian facilities; and (5) providing suitable documentation for effective use of the results of this research.

RESEARCH APPROACH

The research plan for the project consisted of five tasks, as follows:

1. Perform a literature search and review current practice.
2. Identify benefits of separation and affected population groups.
3. Develop measurement techniques to quantify benefits.
4. Develop cost-benefit techniques for evaluation of proposals for separation.
5. Test developed techniques.

This section briefly describes each of these tasks.

The comprehensive search and review of the literature on pedestrian and interacting vehicle factors included economic, behavioral, social, safety, environmental, and health impacts. An active document search effort was maintained throughout the project to ensure that the most recent relevant information was obtained. Also included in Task 1 was an examination of the procedures used by highway engineers, transportation economists, urban planners, and others who perform analyses for the evaluation of pedestrian facilities. The results of a search for this information made clear the need for the project being undertaken. Rapidly rising construction costs, combined with very limited methods for evaluating the benefits of pedestrian facilities, have made it difficult to justify many desired facilities, particularly high-cost structures such as overpasses.

Two specific objectives were established for Task 2. The first major objective was to identify and characterize the population segments that are directly or indirectly affected by pedestrian-vehicular separation. The first section in Chapter Two describes the results of the research findings on affected population groups. The second major objective of this task was to identify and describe all significant direct and indirect benefits of separating pedestrians and vehicle traffic. The impact areas examined included transportation, safety, social, environmental, health, and economics. An iterative development and refinement of benefit items to be measured resulted in categorization and arrangement of items as shown in Figure 1.

The original plan for Task 3 was to identify the best state-of-the-art techniques available for measuring the social, economic, and environmental impacts of proposed pedestrian separation; to identify the deficiencies in using these techniques; and to improve on these techniques as much as needed. Careful examination of relevant literature revealed that very few measurement techniques were available for many of the impacts that the research was intended to cover. Thus, what was anticipated to be a moderate research effort in this area became the major focus of effort for the entire project. The results of this extensive research and development effort on measurement techniques are given in Appendix A.

1. TRANSPORTATION

   1.1 Pedestrian
      1.1.1 Travel Time
      1.1.2 Ease of Walking
      1.1.3 Convenience (Access and Availability)
      1.1.4 Special Provisions for Various Groups

   1.2 Motor Vehicles
      1.2.1 Motor Vehicle Travel Costs
      1.2.2 Use of Automobiles
      1.2.3 Signal/Signing Needs Adjacent to Facility

   1.3 Other Community Transportation
      1.3.1 Adaptability to Future Transportation Development Plans
      1.3.2 Impact on Use of Existing Transportation Systems

2. SAFETY/ENVIRONMENT/HEALTH

   2.1 Safety
      2.1.1 Societal Cost of Accidents
      2.1.2 Accident Threat Concern
      2.1.3 Crime Concern
      2.1.4 Emergency Access/Medical and Fire Facilities

   2.2 Attractiveness of Surroundings
      2.2.1 Pedestrian–Oriented Environment
      2.2.2 Litter Control
      2.2.3 Density
      2.2.4 Climate Control and Weather Protection

   2.3 Environment/Health
      2.3.1 Effects of Air Pollution
      2.3.2 Noise Impacts of Motor Vehicles
      2.3.3 Health Effects of Walking (exercise, fatigue, etc.)
      2.3.4 Conservation of Resources

3. RESIDENTIAL/BUSINESS

   3.1 Residential Neighborhoods
      3.1.1 Residential Dislocation
      3.1.2 Community Pride, Cohesiveness, and Social Interaction
      3.1.3 Aesthetic Impact, and Compatibility with Neighborhood

   3.2 Commercial/Industrial Districts
      3.2.1 Gross Retail Sales
      3.2.2 Displacement or Renovation Required or Encouraged by Facility
      3.2.3 Ease of Deliveries and Employee Commuting
      3.2.4 Attractiveness of Area to Business

4. GOVERNMENT AND INSTITUTIONS

   4.1 Transportation and Land–Use Planning Process
      4.1.1 Public Participation in the Planning Process
      4.1.2 Conformance with Requirements and Regulations

   4.2 Economic Impacts
      4.2.1 Net Change in Tax Receipts and Other Revenue
      4.2.2 Resulting Changes in Employment
      4.2.3 Change in the Cost of Providing Community Services

   4.3 Community Impacts
      4.3.1 Community Activities
      4.3.2 Adaptability to Future Urban Development Plans
      4.3.3 Construction Period

Figure 1. Pedestrian facility evaluation variables.

The primary criteria for development of measurement techniques were ease of understanding and use by planners, designers, engineers, decision-makers, and concerned citizen groups. Although a unitless scoring system was devised for all variables under study to allow use of a broadly based evaluation, a methodology for computing dollar value benefits was also developed where appropriate. A discussion of how measurement procedures were developed is given in Chapter Two. Instructions on the use of the measurement techniques are contained in Chapter Three.

The objective of Task 4 was to develop a comprehensive evaluation methodology that could be used to assess individuals and alternative proposals for pedestrian separation facilities. The method developed combines subjective values that reflect community preferences with the objective measurement techniques developed in Task 3. This combination provides much more than just a "score" for a proposed facility, because its components provide considerable insight on the values of the decision-makers, and on the attributes of the facilities themselves. This added information supports a careful comparison of alternative proposals by identifying the important differences between alternatives. Chapter Two contains a detailed description of the characteristics of the evaluation methodology developed during this research.

The project team devoted considerable effort to discussions with planners, analysts, designers, evaluators, decision-makers, and citizens to obtain information on their needs and desires, their likes and dislikes, on the subject of pedestrian facilities. A questionnaire (App. C) was also distributed to pedestrian facility planners and decision-makers to provide the researchers with data on the relative preferences or values associated with the 36 selected evaluation variables. This questionnaire and its results are discussed in Chapter Two.

The purpose of Task 5 was to thoroughly test the evaluation procedures being developed at actual pedestrian facility locations. Two existing and two planned facilities were chosen as test sites to provide a more complete testing of the developed techniques than had been originally scheduled. Two small facilities, a planned overpass at a hazardous intersection (Rainier Ave. and Empire Way) and a bridge closure (20th Ave. N.E./Ravenna Park) to motor vehicles, both in Seattle, Wash., were analyzed. The successful Sparks Street Mall in Ottawa, Ont., and the proposed Fulton Mall in New York City's Borough of Brooklyn were chosen to test application of the methodology to large-scale facilities. The site selection procedure and the data collection techniques used are described in Chapter Two. Detailed field test data for each of the four sites are given in Appendix B. The form of the data is keyed to the measurement techniques developed in Task 3, and thus serves as an illustration of how evaluation data might be assembled by the users of this report.

ORGANIZATION OF THE REPORT

This final report has been organized to serve two major objectives. The first is to report on the research conducted, the need for the research, and the objectives and procedures followed. These are described in Chapter One. The research results, as detailed in Chapter Two, are intended for the investigator who is interested in knowing how the research was conducted and how the various factors interrelate. Chapter Four contains a summary of the conclusions reached and suggestions for further research.

The second major objective is to provide a user guide to the results of this study. Chapter Three describes potential applications of the techniques developed and presents step-by-step instructions for their use. Appendix A is an integral part of the user instructions, and Appendix B provides four sample applications of the developed methodology and techniques. The material in Appendix C may be of interest to either type of reader.

CHAPTER TWO

FINDINGS

POPULATION GROUPS AFFECTED BY PEDESTRIAN FACILITIES

A major research objective was to identify and characterize the population groups that are directly or indirectly affected by pedestrian-vehicular separation. Examination of the needs of these diverse groups was used to ensure adequate consideration of benefits during the research. This section describes the most significant characteristics of the groups identified.

Captive Pedestrians

Along with the handicapped and the poor, the elderly are particularly vulnerable to the disadvantages of pedestrianism, because alternative modes of transportation frequently are unavailable to them. It has been estimated (Raynes, 1974) that transit-dependent persons comprise 26 percent of the urban populace. Thus, although exact data are not available on the sizes of each of these pedestrian groups relative to the total of all pedestrians, it is estimated that these persons constitute a large fraction of the total. Such "captive pedestrians" are more dependent on walking than are other groups for a variety of trip purposes—shopping, attending schools and churches or places of employment, visiting friends and relatives, and traveling to social and recreational facilities.

Accessibility, travel time, and expanded social contacts are among the principal impacts of pedestrian facilities on elderly pedestrians. In a study of elderly pedestrians in San Antonio, Tex., Carp (1971) concluded that "generally, places to which the most people walked involved basic physical subsistence needs . . . and basic psychological needs." Trips tended to be short. She found that all one-way pedestrian trips reported to her were less than 30 min in length, with most being shorter than 15 min. A major disadvantage of walking cited by her respondents was that many places to which they needed to go were simply too far away.

Elderly people in the San Antonio study admitted to a host of fears having to do with walking. These included fear of attack, an accident, a fall, an inability to complete crossing the street before the light changed, and fear of becoming lost. Responses elicited during interviews led the author to conclude that these people had a strong concept of territoriality. "They felt strongly that vehicles should not invade pedestrian territories; and they, as pedestrians, did not go willingly into automobile territory or onto private property." An interesting result of the study, supported by a follow-up study in San Francisco, Calif., (Carp, 1972), is that those people who walked the most were found to be the most negative in their evaluation of walking as a means of transportation.

Persons over 65 account for almost 25 percent of all pedestrian fatalities (*Accident Facts,* 1975). In a study of the physiological factors associated with elderly pedestrian accidents, Yaksich (1965) found the following factors to be most significant:

- Impaired hearing.
- Less accurate depth perception.
- Decreased lateral field of vision.
- Slower perception and reaction.
- Decreased learning capacity.

Increased susceptibility to injury and decreased ability to survive injury may account in part for a higher incidence of death resulting from injury for elderly pedestrians (Haddon et al., 1961, pp. 242-243).

Handicapped persons have many of the same desires for accessibility and social contacts that elderly pedestrians do. In a case study of blind and deaf individuals in Washington, D.C., it was found that work and shopping trips were the most important walking trips made, followed by recreation trips (Roberts, 1972). The individuals expressed concern for better design of facilities to meet their needs, with more attention to directions and signs. Thus, comfort and convenience were seen as important impacts. In contrast to the study of elderly pedestrians mentioned earlier, "walking was evaluated as a pleasant activity by all groups; they emphasized the desire to do more walking to additional destinations if pedestrian conditions were improved" (Roberts, 1972).

The elderly and the handicapped are usually given special consideration when pedestrian accommodations are designed because these groups are expected to be major users of a facility when completed. Also, the amenities (such as benches) implemented for those specific groups can readily be used by others. Features of pedestrian plans that affect safety, accessibility, travel time, and pedestrian orientation of the environment are likely to benefit all pedestrians, but their perceived importance may be expected to differ for different groups. Solutions geared to one group's needs, however, may not always benefit others. For example, installation of special pavement guidestrips for blind persons do not aid other pedestrians and are of benefit only to specially trained blind persons (Herms et al., 1975).

Frequent Accident Victims

Accident reduction is likely to be an important beneficial result of separating pedestrians and vehicles. National Safety Council statistics for 1974 indicate that only 10 percent of rural highway deaths are pedestrians, but 36 percent of all urban motor vehicle fatalities are pedestrians. In 1975, about 300,000 pedestrians were involved in accidents with automobiles, resulting in 8,119 pedestrian deaths (NHTSA, 1976). The incidence of involvement of children and elderly persons in pedestrian accidents is considerably out of proportion to their relative numbers in the population at large (Wiener, 1969) perhaps due in part to their greater dependence on walking. An analysis of accident records nationwide for 1974 reveals that 25 percent of pedestrian fatalities were children under 14 years of age (*Accident Facts,* 1975).

Studies conducted by S. Sandels at the Institute for Child Development Psychology, University of Stockholm, suggest that developmental factors may play a large role in inhibiting a child's safe conduct in traffic. Among factors cited are: (1) misunderstandings and misconceptions of children regarding traffic rules and the physics of stopping an automobile; (2) lack of experience and limited judgment in traffic; (3) limited visibility because of a child's small size; (4) limited powers of concentration; (5) tendency of a child to be playful and impulsive (van der Does, 1975).

Alcohol plays a serious enough role in accident causation to warrant possible consideration of "intoxicated persons" as a separate group. In a Virginia study, alcohol was claimed as an important contributing factor because "39 percent of adult pedestrians killed were known to have been drinking" (Yu, 1971) at the time of the accident. The classic study by Haddon et al. (1961, pp. 655-678) found that 42 percent of the fatally injured adults in Manhattan had blood alcohol concentrations of 0.10 percent or higher, compared with 8 percent of a very carefully selected control group. This study also provides insight to many other aspects of pedestrian fatalities.

Efforts at reducing pedestrian accidents through stricter enforcement of pedestrian traffic laws have been largely ineffective. Attitude seems to play a crucial role. A study of the responses of elderly pedestrians to a campaign of enforcement of pedestrian traffic rules revealed that illegal crossings following the campaign reverted to their pre-campaign level, except when a police officer was present

(Wiener, 1969). In another study, a comparison was made of the number of unsafe acts observed relative to the total number of pedestrians at a Brooklyn, N.Y., intersection, both before and after installation of pedestrian traffic signals. No significant difference in pedestrian behavior was noted. According to the authors, "assuming that changes in safety behavior are a valid criterion for evaluating the effectiveness of a method designed to reduce accidents and that the safety behavior observed was a representative sample, it may be concluded that pedestrian traffic signals are not an effective method for reducing pedestrian accidents" (Flieg and Duffy, 1967).

Because incorrect actions of pedestrians and drivers, combined with poorly designed pathways, are frequently the cause of pedestrian accidents, it has been commonly assumed that education, law enforcement, and pedestrian and vehicle traffic controls, if properly used, can prevent these accidents. On-going FHWA and NHTSA pedestrian safety research programs have quantified specific types of pedestrian accidents and have examined selective countermeasures to these types. Examples are elimination of parked vehicles to enhance driver/pedestrian visibility, one-way streets to reduce attention-demanding conflicts, and greater use of illumination and retroreflective materials. Further insight on control of pedestrian accidents can be obtained from the papers by Baker (1975), Neutra and McFarland (1972), and Snyder and Knoblaugh (1971), which note that an important accident countermeasure for separate pedestrian and vehicle pathways is prevention of pedestrian access to vehicle pathways by means of effective physical barriers that ensure conflct elimination.

Other Pedestrians

Other sizable groups of pedestrians, including shoppers, people out for a meal, and persons conducting business (personal or company), are affected by the quality of pedestrian facilities provided for them, particularly if accessibility and travel time are involved. Downtowns abound with these types of pedestrians, especially around the noon hour. One planner has noted that although downtown shopping trips outnumber business trips, "the average business-walking trip is longer than the average shopping trip, so that the total distance walked for business is about the same as the distance walked for shopping" (Morris, 1967). He adds that knowledge of the purpose and length of pedestrian trips will permit installation of pedestrian amenities at appropriate intervals to meet the walker's needs. The tendency of shoppers to make more than one stop per trip underscores an accessibility factor because there is "a close correlation between the convenience—the mutual accessibility—of stores and the interaction of shopping between them." For many shoppers, the level of comfort and convenience available may sometimes mean the difference between making a trip or not.

Although most individuals use other modes of transportation to commute to their places of employment, all must become pedestrians for at least part of the trip. Travel time and accessibility are important impacts to commuters, particularly at terminals and transfer points.

In parts of many cities, tourists are a notable subgroup of pedestrians. Indeed, cities such as Boston have identified and posted signs to signify pedestrian routes that connect various points of interest. With interest in seeing the sights, including cultural and historic points, route choices for tourists may be more strongly guided by aesthetic considerations than those of most residents. Although safety and travel time impacts are important, the fact that the trip is not made out of necessity causes greater emphasis to be placed on the comfort and attractiveness of the immediate surroundings. This is likely to be true as well for the stroller, the casual walker who is out for relaxation or exericse, perhaps with no particular destination in mind, and to a certain extent for the jogger.

Other Affected Groups

Bicyclists tend to straddle the line separating pedestrians from motor vehicles. Although they are legally subject to most of the laws governing motor vehicle operations, there is often an overlap into pedestrian territory, particularly for the young rider. For example, a bicyclist approaching a pedestrian overpass can easily dismount and become a pedestrian guiding a bicycle, provided ramps, rather than stairs, are provided for access. In other circumstances, however, bicyclists and pedestrians are likely to interfere with one another. Where facilities are to be shared, sufficient width should be provided to allow for a difference of speeds. Where separation is desired, signs or other deterrents may be needed to restrict entry.

Vehicle operators are often most directly impacted by a program for separation of pedestrians and vehicles, particularly if the plan calls for establishment of auto-free zones. In many instances, the impacts are beneficial. Construction of an overcrossing imposes no new restrictions to motorists and usually will improve traffic operations. A reduction in accidents and travel time often results, and decreases in stop-and-go driving usually lower the costs of operating vehicles. Even the establishment of auto-free zones may reduce vehicle costs, in spite of slightly longer travel distances, by concentrating pedestrians in the zone and reducing conflicts on adjacent arterials.

Property owners and residents of neighborhoods in which pedestrian facilities are under consideration will be concerned with a number of other potential impacts. Community cohesion may be a principal concern. Reduction of the barrier effects of a freeway through construction of an overpass, for example, will usually be viewed favorably by nearby residents. In some cases, construction of a facility will mean relocation of a number of residences or businesses. Residents will also be impacted by changes in the surrounding environment, including air pollution, water pollution, changes in noise levels, and by aesthetic considerations. Where a facility is financed locally, taxpayers and property owners may be the same individuals. Where financing is derived from a wider tax base, the majority of taxpayers will tend to be less impacted by the immediate physical and social impacts of a facility, but will share the property owners' concerns for the economic impacts. This group is directly affected by the negative impacts of construction and maintenance costs.

Other special interest groups may be strongly concerned with the impacts of a potential facility, even where the effects on them may be neither direct nor immediate. Thus, environmentalists might seek to minimize negative impacts of air, water, and noise pollution, land use, resource depletion, or ecosystem changes to the community at large. Business groups might well be impacted by changes in land use and economic development resulting from a pedestrian facility, perhaps focusing on a longer time frame than certain other groups.

Political representatives of federal, state, and local governments may, in a sense, feel any or all of these impacts. Which impacts are most important will depend on the immediate circumstances, but one might expect that economic and cost consideration would usually be among them. In addition, environmental concerns, particularly relating to regional goals, might be of great concern. Although the day-to-day impacts on travel time and vehicle operating costs may be less of an issue, expectation of a sizable decrease in accidents could be quite important to policy-makers.

DESCRIPTION OF EVALUATION METHODOLOGY

State of the Art

The preceding sections clearly indicate a growing need for pedestrian facilities and for evaluation methods to assist in their design and selection. Earlier work has been done by others in two important areas: criteria or warrants for installation and cost/benefit analysis.

The City of Seattle, Wash., in a study of pedestrian overpasses (van Gelder, 1970), established a point scoring system and applied it to a large number of intersections in the city as potential sites for grade-separated pedestrian crossings. Thirty sites were examined in detail using the scoring system developed. Seven factors were assessed, as follows:

Volume factors:	
Pedestrian volume crossing	40%
Vehicle volume crossed; vehicle velocity; street width	
Accidents:	15%
Pedestrian accident experience	
Vision and miscellaneous:	45%
Clear sight distance	
Pedestrian age	
Adaptability of the crossing to the terrain	
Pedestrian and vehicle delay and convenience	

A priority weighting system was devised to "limit the emotional bias and unsubstantiated opinions which are always a factor in such determinations." The weights of the selected evaluation factors were limited by percentages as indicated. Quantitative guidelines were also developed to aid in determination of values for each factor. The process was considered to have "significant value as a screening process and as a guide to a general priority ranking for administrative decision."

The New Jersey Department of Transportation (Batz et al., 1975) has developed a similar but extended system to account for variations found among different types of sites. Two measurement systems were developed, one for sites with existing pedestrian activity (e.g., intersections) and another for those with no pedestrian activity either because pedestrians are forbidden (freeway crossings) or because of physical features such as a center barrier. A weighted point scoring system was used for each type of site, as follows:

Locations with existing pedestrian activity:

Factor	Points Avail.
Pedestrian and vehicle volume with peak-hour delay factor	80
Sight distance, desirable gap distance, or pedestrian signal timing	50
School crossing	30
Distance to nearest alternate crossing	30
Engineering judgment	10
All	200

Locations with no pedestrian activity:

Factor	Points Avail.
Trip generation	70
Distance to nearest alternate legal crossing	70
Engineering judgment	60
All	200

This procedure includes a more extensive quantitative system for evaluation of points to be awarded in each factor group listed. One of the system's authors (R. L. Hollinger) also coauthored a report (Reilly et al., 1974) describing a methodology for evaluating transportation alternatives using cost-utility analysis.

Scott and Kagan (1973)* performed the first major work attempting to compare costs and benefits of facilities for pedestrians. They developed a detailed description of facility types and provided a good treatment of construction costs by component for different types of facilities. However, benefit calculations were restricted to the following costable benefit factors:

Reduced cost of vehicular delay time.
Reduced cost of vehicular operation.
Reduced cost of pedestrian injury and fatality.
Reduced cost of vehicular accidents of pedestrian causation.
Reduced cost of alternative crossing controls.
Reduced cost of pedestrian roadside delay.
Reduced cost of alternative transportation modes.
Reduced cost of pedestrian trip time.

Improved linkage of neighborhood and other land uses.

Their report contains an excellent summarization of many factors involved in consideration of pedestrian facilities, such as pedestrian travel demand and typical walking distances.

Each of these earlier efforts provided valuable information to the present research effort and the broad-based evaluation methodology developed incorporates and extends the most useful aspects found in each.

* A summary of this report was prepared by Prokopy (1974).

Selection of the Evaluation Approach

The proper evaluation of pedestrian facilities requires identification and comparison of all relevant attributes of such facilities, along with the preferences of affected interest groups for such attributes. In addition, the evaluation methodology must be reasonably easy to learn and to apply to a variety of facility types.

Evaluation of alternatives having multiple outcomes or results for diverse interest groups has been the subject of research in several disciplines over the past ten years. Table 1 lists the techniques that are major contenders for the conduct of such evaluations, in approximate order of increasing difficulty and sophistication. Each approach varies in the amount of data that users are required to generate for the analysis. Table 1 also provides comments on the applicability of each method to evaluation of pedestrian facilities.

Briefly, the first two methods (economic and cost-effectiveness analysis) do not provide a single final number that can be used for evaluation of alternatives that will result in a large number of different impacts. The last two methods (decision analysis and game theory) are overly sophisticated, in the researchers' view, for comparison of reasonably similar and standard types of alternatives where risk attitudes, uncertainty, or controversies among different interest groups are unlikely to play a major role in the analysis. Three other highly technical approaches—logit models of observed behavior to obtain scalar values, principal components analysis, and linear programming evaluation techniques—were considered and rejected because the data requirements for applying such approaches far exceed the data available for pedestrian facilities.

The approach selected and described in this report is a scoring, rating, or matrix method, in which all relevant attributes of a pedestrian facility are assigned unitless scores over a designated range (through specified measurement techniques) and the scores are weighted and summed to a total. The procedure is intended to facilitate identification of attributes to which the score is sensitive, improvement of weak design features where advisable, and discussion or bargaining among interest groups as to desirable levels of quality for different attributes. In addition to measurement

TABLE 1

RANGE OF POTENTIAL METHODS FOR EVALUATING PEDESTRIAN FACILITIES

Method	Comments
1. Economic analysis (including engineering economy and benefit-cost analysis), covering only results readily valued in dollars. (Grant and Ireson, 1970; Andersen et al., 1975).	This approach is too limited because many important effects are not readily valued in dollars; however, see comment on method 4 below.
2. Cost-effectiveness analysis, entailing the measurement or description of all significant outcomes, followed by an analysis of trade-offs among alternatives and a judgmental decision in cases where one alternative is not dominant for all outcomes and interest groups. (Manheim et al., 1975; Hovey, 1968).	While cost-effectiveness analysis has been useful in extending the range of attributes that are measured, it is weak in resolving multi-attribute, multi-interest group issues unless, as indicated, one alternative is clearly preferable to the others for all outcomes and interest groups.
3. Scoring, rating, or "matrix" schemes, in which project objectives are defined, criteria and measurement scales are developed and applied, and results are weighted by relative importance (Hill, 1968; Jessiman et al., 1967; Nash et al., 1975; Miller, 1969).	Scoring methods, when carefully applied with reasonably complete, linear, and independent criteria, can can produce useful and consistent results, though the resulting scores are often not intuitively meaningful.
4. Decision analysis; all significant outcomes valued in dollars; value trade-offs, time preference, uncertainties, and risk attitude all explicitly considered; minimal definition of goals as "targets," but relative values are defined for different outcomes (Raiffa, 1969; Howard, 1968).	Essentially a scoring method utilizing dollar values, but augmented by superior modeling capability (e.g., decision trees) and ability to consider uncertainties and risk attitudes. Tends to be expensive and to require considerable training or technical assistance to apply, including the same care in selection of criteria as method 3.
5. Game theory: adds consideration of bargaining strategies and threats, hence is a more general or "rational" approach for multi-interest group issues (Spinetto, 1975).	While sound in theory, the game theoretical approach has not yet been widely applied and entails intensive orientation efforts for users plus consulting assistance to apply the mathematics. Could only be feasible for very costly and controversial facilities.

scores for each attribute, the total score produced can also be a useful guide to decisions among alternatives.

The unifying feature of a scoring approach to project evaluation is that all of the variable scores are weighted by individual preferences or values of persons affected by the project being evaluated. Its main advantage over purely economic approaches is that nonmarket effects are considered along with values and preferences that are revealed in the marketplace. It is also possible, if scores are linear and additive, to convert the scores into dollar equivalents and thereby conduct the evaluation as an economic analysis. Guidelines for these procedures are provided for such steps if desired by the user.

In designing the scoring approach for this study, the researchers paid close attention to past criticisms of scoring methods, and in particular incorporated the following features to make the approach internally consistent and acceptably rigorous:

- The 36 outcome variables included in the analysis are reasonably independent, to minimize double counting, and together describe all features of pedestrian facilities believed to be significant.
- Variables are grouped into categories by affected interest groups (pedestrians, motorists, other travelers, the environment, the community, businesses, and government) to facilitate analysis of trade-offs between groups.
- Measurement scales have been devised for all variables, even those usually considered intangible or qualitative, over a standard range of +10 to −10, corresponding to the highest and the lowest reasonable values, respectively, for each variable. The resulting variable scores can be weighted by preference or relative importance multipliers before the resulting relative benefit values for each variable are incorporated into a total score for each facility. For example, if variable 1 is weighted twice variable 2, it implies that each point for variable 1 is twice as valuable as each point for variable 2.
- Two levels of descriptors below the variable level—first "components" and then "characteristics"—are used to allow appropriately detailed measurements of most variables. Scores for these levels are combined in various ways (described in the section on measurement techniques later in this chapter) to comprise the +10 to −10 range for a given variable. In most cases, the actual data item to be evaluated is so specifically defined that the allocation of points is essentially a factual determination. A few variables require the evaluator to assign a point score based on subjective judgment and descriptive guidance provided with the measurement techniques (App. A).

Some criticisms of scoring methods that require further comment are as follows:

Criticism. The practice of adding scores does not accommodate nonlinearities in different outcomes.

Comments. Careful definition of a standard scale from +10 to −10 in which the ends of the scale are selected as extreme but still reasonable values minimizes nonlinearities. For example, the selected rating scale does not include the possibility of 30 percent grades on pedestrian ramps, which would certainly be a nonlinear and extremely negative point. Also, even the +10 to −10 scale is nonlinear for some variables, although this was avoided as much as possible in assigning scale values.

Criticism. No general significance can be attached to weights that are developed with a particular project in mind, so comparison of different types of projects is questionable.

Comments. The rating scheme is probably best suited and least controversial for the simple evaluation problem of comparing mutually exclusive alternatives, such as overpasses versus underpasses for a given location. Nevertheless, assuming that the points allowed for different categories of outcomes are of equivalent scale after weighting, it follows that diverse types of facilities can be compared. For example, if a set of mid-block overpasses is being compared with a new pedestrian mall, the greater number of items that can be rated favorably for the mall might accord it (if both facilities are well designed) a higher rating than the overpasses. Hence, at the same price, the mall should be preferred to the overpass, or should be built first.

Criticism. Scoring all attributes of an alternative, rather than just outcome variables, interferes with developing an understanding of how decision variables (those controlled by the high-level decision-maker, such as project cost) and state variables (those outside his control, such as weather) interact to produce the outcome variables.

Comments. The scoring of all attributes of pedestrian facilities is not suggested, only their outcomes, although many of the outcomes are a function of decision variables for the design of the pedestrian facility—such as climate control, surface texture, facility capability, and public participation in the planning process.

Criticism. Different interest groups will have different weights for different variables and facilities, and such weights cannot be well determined in advance.

Comments. Results of a questionnaire (described in Chapter Three) have been used to identify general weights for facility types that emphasize goals of either safety or sociability. In addition, decision-makers are encouraged to specify their own weights for particular facilities, utilizing questionnaires or other public participation techniques to help define the weights.

There is a strong rationale for adding or modifying weights for variables *after* quantification (or measurement) of the variables for a given type of facility. Nash et al. (1975) state:

> Relative importance weights attached to various objectives in matrix evaluation methods indicate the rate at which the community . . . is prepared to trade gains and losses on one objective with gains and losses on another [based on the magnitude of measurements] . . . persons weighting relative objectives must have available to them detailed information on project consequences.

It is therefore recommended that several existing or proposed facilities within each community actually be evaluated before a final set of weights for the categories and variables is selected for the community. The discussion of suggested weights (in Chapter Three) derived from questionnaire returns is intended to assist in selecting an initial set of weights to serve as a basis for community discussion or for preliminary evaluation of a limited number of facilities. An important point is that zero weighting values may be used to reflect decision-maker opinion, or to reduce evaluation complexity. For example, a quick evaluation of a pedestrian safety countermeasure might use zero weights for social or institutional impacts.

Described next are: (1) the complete evalaution process that the suggested scoring method supports, and (2) how to treat costable variables separately if that is desired. The measurement techniques for all 36 variables are presented in Appendix A, and details of their use are presented in Chapter Three.

Suggested Evaluation Process

Although the steps of an evaluation process can be varied in depth or sequence to suit the needs of a particular facility, a complete process might contain the nine steps shown in Figure 2. Of these steps, the major concern of this report has been in defining steps 5 and 6, development of criteria and measurement techniques and their application for pedestrian facilities in general. Conduct of the other seven steps is by now well-documented for studies of other transportation modes, particularly in Andersen et al. (1975), Manheim (1975), Thomas (1968), and Winfrey (1971); the recent consensus of each step is summarized in the following.

Step 1. Identify Goals for Accommodating Pedestrians

This step entails definition of pedestrian facility goals for a community. Such goals might begin with general policy statements regarding pedestrian safety and access, but should preferably be translated into tentative long-range plans—or alternative possibilities—for each type of facility that is needed.

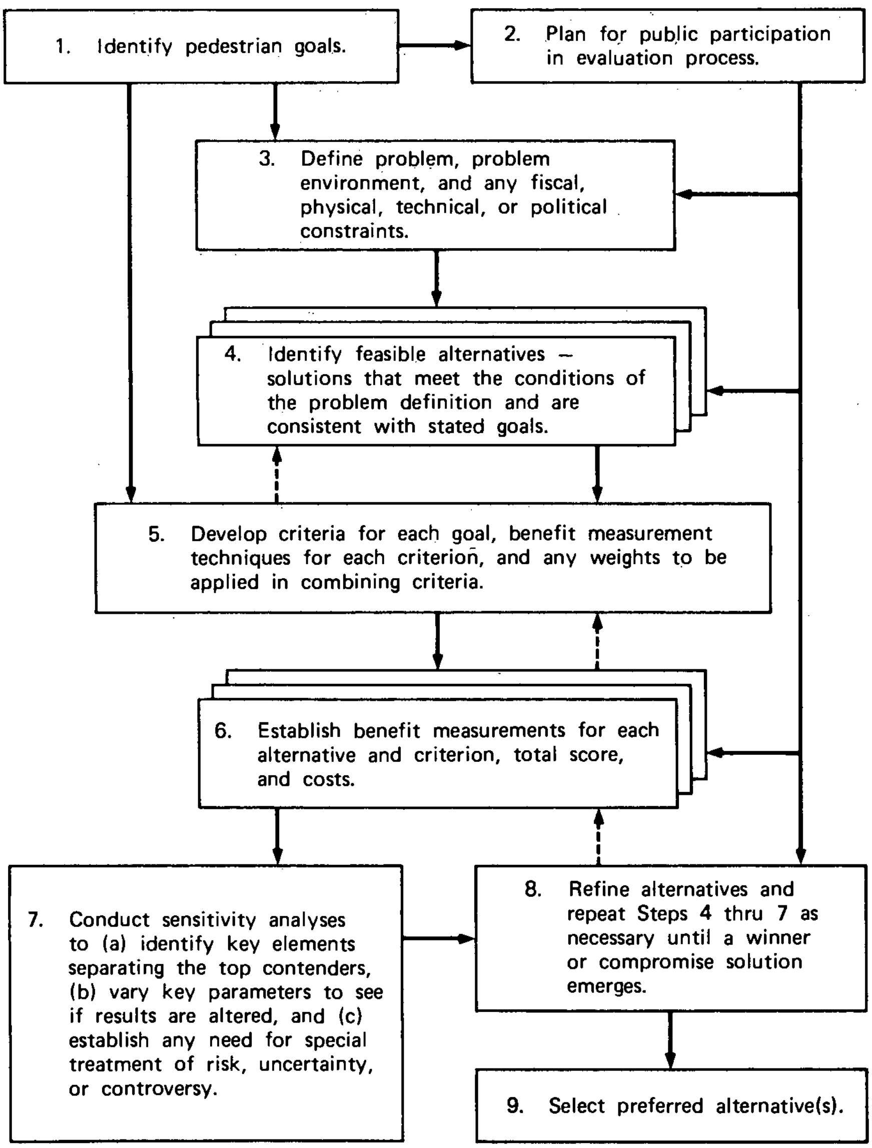


Figure 2. Suggested evaluation process.

Step 2. Plan for Public Participation

The need for involving affected interest groups in government decisions has been well established in recent years, especially for decisions on transportation facilities that represent long-term investment with a broad variety of public impacts. Therefore, a variable for rating public participation has been included in the planning process (4.1.1). The discussion for this variable should be consulted in connection with Step 2 of the evaluation process. When the plan for public transportation is in operation it can, as shown in Figure 2, become an input to subsequent tasks. Public involvement in the evaluation of projects is frequently criticized as producing imperfect renderings of consumer preferences and taxpayer willingness to pay because of the nonrepresentative process by which the public participates and because of conflicting personal interests. In response, the variable measurement scales and the weighting system have been selected and designed to facilitate explicit identification of conflicting goals and preferences. Hopefully, this will assist in the resolution of conflicts by concentrating on results rather than differences.

Step 3. Define the Problem

The nature of the existing pedestrian problem, its environment, and any fiscal, physical, technical, or political constraints that affect the selection of a solution should next be described. Consideration should be given, for example, to the possibility that the problem could be solved more economically through means other than pedestrian facilities, or that the cost of proposed facilities is beyond available funds.

These three initial steps—identification of goals, the plan for public participation, and definition of the problem—should be closely linked. Many communities already have routine approaches to all three steps for pedestrian safety facilities. In cases such as a major pedestrian mall or auto-restricted zone, it may be advisable to give more detailed attention to identifying the relevant interest groups and their goals, the mode of public transportation, and problem definition. If further information is needed, Manheim's guidelines for these steps (Manheim et al., 1975, pp. 15-77) are quite complete and illustrated with case studies.

Step 4. Facility Planning and Design

After the pedestrian-vehicle conflict problem has been identified and solution goals have been established, plans may be drafted for a facility to remedy the problem. Two sources (Eckmann et al., 1975, and Barrett, 1972) describe the pedestrian planning process in detail. The following discussion draws liberally from both of these references, especially the first, which is the Institute for Public Administration's study of pedestrian needs and accommodations.

The suggested tasks for the design process are as follows:

1. Determine the configuration of existing land uses and delineate the boundaries of the study area. Pedestrian traffic generators (parking lots, transit stops. etc.) and pedestrian attractors (stores, offices, homes) should be identified on the land-use map.

2. Perform a pedestrian origin/destination (O/D) study. This is done by specifying all possible movements between the generators and attractors, including walking from one transportation mode to another; eliminating spurious and unimportant movements from the list; estimating hourly flow based on observations, building populations, or standard trip generation rates; and drawing desire lines for various classes of pedestrians during the peak hours for those groups.

3. Perform traffic counts to establish the validity of the network found through the O/D study and to establish the actual number of walkers on the street.

The result of these three tasks should be a clear and accurate picture of the existing walking pattern, by user type, and how it relates to the land uses of any given place.

4. Track individuals within the area to observe their behavior and to determine where comfort and discomfort are extreme.

5. Use observation to examine areas of overlap, dense use, and special use. In fact, all parts of the pedestrian system should be subjected to some direct evaluation by observation. These observations should be recorded on a map to show problems and opportunities (by user group, when appropriate).

6. Project a reasonable future showing future land-use patterns and population projections by type. The analysis of pedestrian users and land uses can aid in projecting the effect future changes will have on the distribution of walkers. Thus, future pedestrian patterns can be mapped by user type, whose needs can be assumed to be similar to those of present users of similar type.

7. Use questionnaires, workshops, or other means to elicit subjective views of future needs and goals. This information should also be gathered and used in categories by user types.

8. Generate a series of alternative designs that make specific proposals of pedestrian improvements for each pedestrian group.

These proposals should be keyed to the map of the existing and future pedestrian pattern. Although responding to special problems and opportunities, the design recommendations should be keyed primarily to the comfort factors of the users of the street. When following these steps, it is important to remember that the planning process is an iterative one. Thus, steps may be repeated or performed in different orders as more data become available. Further specific guidelines for special situations are given in the following.

In areas of high use by elderly pedestrians, benches should be placed where the elderly can rest and socialize. Ramps should be provided to eliminate the inconvenience and hazard of curbs. Traffic lights should be timed to allow slow walkers sufficient time to cross. About 35 sec for 50 ft of roadbed is recommended.

Over the long term, construction of housing for the elderly within a one-block walking distance of parks, libraries, and inexpensive shopping areas should be encouraged. This would accommodate social/recreational and shopping trips, which are the most common purposes of walks by the elderly. Construction of housing for the elderly in exclusively residential areas will force them to take uncomfortably long walks or use vehicular travel to reach locations that are comfortable to them.

In areas used by children, such as the neighborhoods of playgrounds and schools, pedestrian routes should offer many shortcuts, which children prefer, and should minimize conflict with traffic and traffic controls. Children are the most impatient of all pedestrians, and they are also the most curious and observant. Thus, playground equipment and educational kiosks along their walking paths should attract their attention and occupy their enthusiasm.

In areas of intense shopping activity, a broad network of path options should be provided over a minimum area of five square blocks, including the zone of greatest pedestrian shopping trip density, to accommodate the average walking trip length of shoppers. Path options are important for shoppers who walk spontaneous and meandering routes.

In areas of intense office employment, especially between these areas and nearby residential neighborhoods, long, direct, unobstructed routes should be designed for pedestrian travel to work. Pedestrians will walk lengthy routes to appreciate unobstructed and uncrowded paths.

Over the long term, residential and employment areas should be developed within walking distance of each other. Many people prefer to walk to work, even over long distances, because it is convenient, economical, and healthful.

Step 5. Select Benefit Criteria, Weights, and Measurement Techniques

As the focal point of this research, great care was taken in selection of the 36 evaluation variables (Fig. 1) and in development of specific measurement techniques for each variable. The selection procedure began with development of lists containing hundreds of potential variables identified during a literature review and discussions with many researchers and planners concerned with pedestrian transportation. The project team also devoted considerable effort to discussions with planners, analysts, designers, evaluators, decision-makers, and citizens to obtain information on their needs and desires, their likes and dislikes, on the subject of pedestrian facilities. A questionnaire (App. C) was distributed to pedestrian facility planners and decision-makers to provide the researchers with data on the relative preferences or values associated with the 36 selected evaluation variables. This questionnaire and its results are discussed later in this chapter.

Items on the lists were grouped and ordered in a long iterative procedure that ended only after the collection and evaluation of test data from actual pedestrian facilities. Many informal discussions at these field sites helped shape the final list. In addition, two general review meetings were held with an aesthetics expert, an environmental planner, an urban planner, a noise expert, a transportation economist, and several transportation planners. These meetings were structured to critically review the grouping, order, and content of the individual impact items under consideration. The first general meeting was held before the measurement techniques were fully developed. The second was held after their development to reassess the original selection and to consider information added by the newly developed measurement techniques.

The evaluation variables were arranged in a five-level hierarchy of items. At the top level are four major categories: transportation; safety/environment/health; residential/business; and government and institutions. At the second level are groups such as pedestrians, motor vehicles, and other community transportation. The third-level variables are the heart of the evaluation methodology. As an example, the variables for the group pedestrians (1.1) are: travel time (1.1.1), ease of walking (1.1.2), convenience (1.1.3), and special provisions (1.1.4). In the evaluation methodology, a means for scoring is developed for each of the 36 variables identified during this research. Fourth- and fifth-level terms, components, and characteristics were also selected for those variables that include many subvariable factors. For example, the variable climate control and weather protection (2.2.4) is measured with the use of four component scores: heating, air conditioning, ventilation, and protection. Protection is in turn scored by considering such characteristics as exposure to sunlight, winds, precipitation, and so on.

The key question for including a variable was: "What items will or could significantly affect, or be affected by, a separated pedestrian facility?" The next important criterion in the variable selection process was to avoid "double counting" by including a single variable in several categories or groups (usually under different names or descriptions). This was managed by carefully defining each variable selected for consideration. Examples of these definitions are given in Appendix C. Similar, but less serious, problems occurred at the component and characteristic levels, and these were resolved by limiting the impact of a component such as lighting to the purpose of the variables under consideration. Thus the item "lighting" was functionally subdivided into its accident prevention, crime prevention, sign illumination, and aesthetic characteristics, and each characteristic was incorporated into only one variable to prevent duplication.

A complete description of how user-selected preferences for the 36 variables are established and combined with objective measurements for each variable is presented in Chapter Three under "Instructions to Users." A discussion on development of measurement techniques for the variables is presented in the next section of this chapter.

The developed method thus combines subjective values that reflect community preferences with objective measurements for each variable under consideration in the evaluation of pedestrian-oriented facilities. This combination provides much more than just a "score" for a proposed facility, because its components provide considerable insight on the values of the decision-makers, and on the attributes of the facilities themselves. This added information supports a careful comparison of alternative proposals by identifying the important differences between alternatives.

A feedback arrow is shown between Steps 5 and 4 in Figure 2 to indicate that the criteria of Step 5 should affect the detailed design of alternatives in Step 4.

Step 6: Establish Outcome Measurements

Outcome measurements are determined using Appendix A, which is a self-contained workbook presenting the measurement technique to be used for each of the 36 evaluation variables. The feedback arrow shown between Steps 6 and 5 in Figure 2 indicates that the results of applying the measurement techniques may suggest modifications to the criteria being used or to the detailed design of an alternative. An example would be obtaining a large negative value (such as −9) for any variable such as accident cost (2.1.1) or noise (2.3.2).

The primary criteria for development of measurement techniques were ease of understanding and use by planners, designers, engineers, decision-makers, and concerned citizen groups. Although a unitless scoring system was devised for all variables under study to allow use of a broadly based evaluation, a methodology for computing dollar value benefits was also developed where appropriate.

Step 7: Conduct Sensitivity Analysis

Sensitivity analysis is carried out in three parts; the first is observation of those variables for which low scores are obtained and the proportion of the total difference between alternatives (or between an acceptable and unacceptable total score) that is caused by each such variable. This information is used to consider methods and costs for upgrading less attractive facilities (see Step 8).

The second part of the sensitivity analysis is to let the key parameters for the study vary over their possible ranges of values (presuming that the most likely values have been used so far) and see whether the results of the analysis are altered. Examples of such parameters are the future level of pedestrian and highway traffic and the prospective growth of retail trade within the service area of the pedestrian facility. The failure of some malls to improve retail trade as expected is a case in point. If the uncertainties in such variables would cause a change in the rank order of total scores for the alternatives or in the number of attractive versus unattractive alternatives, there may be a case for repeating the analysis in a probabilistic mode. This would require assignment of probabilities to different ranges or values of the state variables to which the results of the analysis are sensitive; for such procedures, refer to the literature on decision analysis (Howard, 1968; Raiffa, 1968).

The third part of the sensitivity analysis is to consider whether serious disagreements may take place over the proper weights to use for different criteria. This may be likely among persons who are individually affected very favorably or unfavorably by one or more impacts or design features of the facility, and would accordingly wish to weight such impacts more heavily. The resolution of such disagreements is an individual matter. Although a majority voting rule can usually resolve a particular issue, it may leave a disgruntled minority unsatisfied. If the support of that minority is essential or desirable for a particular facility, compromise solutions (including design modifications) could be further explored.

Step 8: Refine Alternatives

The eighth step in the evaluation requires choices among the following options:

- Refine one or more alternatives as suggested by results of the first part of the sensitivity analysis in Step 7, and repeat Steps 6 and 7.
- Expand the evalaution to consider risk or uncertainty, or to improve the method of conflict resolution (the need for which is also identified in Step 7).
- Proceed with Step 9, selection of the most acceptable alternative(s).

Two key evaluation process issues are the total time and effort required to get to this point in the analysis, and how much additional effort (if any) is warranted to refine the analysis further. There are no fixed rules for such issues, but the following general guidelines may be of assistance:

- Corporations often consider a budget of up to 1 percent of the cost of the completed project acceptable for evaluation efforts supporting a decision to go ahead with the project or not. Such a budget would be exclusive of facility design costs.
- The researchers' experience in working with Step 5—probably the most time-consuming technical step in the evaluation process for the case studies—suggests a range of 2 working days for a simple project, such as an intersection overpass, to 30 working days for a conversion of a major street to a pedestrian mall. These estimates assume the availability of certain existing data, such as vehicle volumes, and accident histories. They also assume that the evaluator is experienced with such pedestrian facilities.
- Requirements for public participation and interaction, if extensive, could be very time-consuming and are not included in the foregoing estimates.

Step 9: Select Preferred Alternative(s)

The last step in the evaluation process is the first step in the implementation process—a commitment of financial and other resources to the preferred alternative or alternatives. This is listed as a separate step because the formal process of selecting alternatives entails two important considerations:

- Economy study constants for summation of costable data.
- Decision rules for project selection.

Economy Study Constants

For those impacts of a pedestrian facility that are measurable in dollars *or* for the case where all criteria ratings are translated into dollar equivalents, it may be desirable to compare the cost of a facility with its dollar benefits, discounted to present value, over its economic life. Other sources (Andersen et al., 1975; Grant and Ireson, 1970; Winfrey and Zellner, 1971) provide detailed guidance for selection of economy study constants and the conduct of economy studies. The following is a synopsis of current thinking on these matters (chiefly from Andersen et al., 1975):

• *Analysis period and residual value.* An analysis period of about 25 years is suggested for pedestrian-oriented structures. An even longer economic lifetime is likely, but traffic and other projections are not normally available beyond 25 years. Residual value should be based on the remaining economic life, but a rule of thumb could be the full cost of land plus 50 percent of the cost of structures.

• *Discount rate and risk.* The discount rate for present-value calculations should represent the real opportunity cost of capital to the taxpayer, estimated at about 4 percent, if future benefits and costs are calculated in constant dollars. If future benefits and costs are adjusted for expected price increases, the expected average rate of inflation should be added to the 4 percent. (To obtain the sum of two interest rates, add their product to their sum. For example, the sum of 4 percent and 5 percent would be $4\% \times 5\% + 9\% = 9.2$ percent. Thus, the real rate of return that would total 10 percent (the minimum rate currently required by the Office of Management and Budget for most Federal Government investments) with a 5 percent rate of inflation is approximately 4.76 percent.) A risk premium of up to 1 percent is sometimes added to allow for uncertainty, but it is preferable to treat risk and uncertainty explicitly by estimating a range of benefit or cost estimates (Grant and Ireson, 1970, Ch. 14; Howard, 1968).

• *Calculation of benefits for induced travel.* For facilities where a different level of pedestrian or vehicle traffic is estimated than in the base case or "do-nothing" alternative, the average of traffic with and without the facility should be used in calculating total benefits. This approach yields the "consumers' surplus" for the facility, a concept explained in Andersen et al. (1975).

• *Value of travel time.* The value of travel time savings for motorists and pedestrians is usually included in economy studies and is based on their demonstrated willingness to pay for such savings. Suggested current values for motorists are provided in Section 1.2.1.2 of Appendix A, and values for pedestrian travel time savings are provided later in this chapter under "Treatment of Costable Variables."

• *Choice of study years.* In cases where only the criteria rating scheme is used for comparison of alternatives, a single future year can be chosen for comparison of all variables. This should probably be about ten years after the facility is completed, to account for its full effect on pedestrian travel and other impacts. In cases where costable benefits are being calculated, it is recommended that two study years be used, one early in the period (such as the first full year of operation) and one later, probably year 10 or 15. Present-worth factors can then be used to find the equivalent value of the total stream of benefits.

Decision Rules for Project Selection

The usual rule for economic efficiency in cases where all costs and benefits are measured in dollars is to select the project or set of projects that yields the greatest net present value, which is defined as the difference between the present value of the benefits received from the projects and the costs of implementing the projects. Where there is a budget constraint of total project construction costs, this decision rule amounts to maximizing the present value of benefits for the available budget. Then if there are several independent projects to choose from, selection of projects in the order of declining benefit-cost ratios will obtain the set that maximizes present value (see Andersen et al., 1975, for a full discussion of using benefit-cost ratios for project selection, and Grant and Ireson, 1970, for guidelines on using the internal rate of return for project selection in a consistent manner).

In cases where all costs and benefits are not measured in dollars, such as the proposed scoring approach to pedestrian facility evaluation, decision rules are not so readily formulated, and eventually depend on some translation of points into dollar equivalents. For the purpose of illustration, consider a cost-effectiveness approach in which the cost and the score (as a proxy for effectiveness) of each facility is compared. Assume first a set of alternatives—A, B, C, and D—that score and cost as follows:

Alternative	Score	Cost ($1,000)	Points/ $1,000
A	100	150	0.7
B	100	100	1.0
C	150	100	1.5
D	200	200	1.0

Figure 3 shows the same data graphically.

It is clear that alternative B is preferable to A because it costs less and achieves the same score; and C is preferable to B because it achieves a higher score for the same cost. But what of D? Alternative D has a point-per-$1,000 ratio equal to that of B, but when D is compared to C, the added score is 50 points and the added cost is $100,000. This gives an incremental (or marginal) ratio for D to C of only 0.5 points per $1,000. So, incrementally, D offers less benefits per dollar than A, B, or C. Thus, C is the most preferable alternative.

To describe a project selection procedure, one must first be able to establish an acceptable score per $1,000. This is called an "acceptable level." Whatever this level is, *it has*

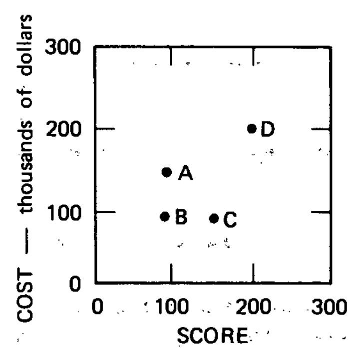


Figure 3. Cost-effectiveness of four sample alternatives.

the effect of setting a dollar equivalence to the score, because only projects with a higher score per $1,000 would be judged worth constructing. Based on experience with past projects, there may turn out to be different levels for different facility types, which would indicate the degree of preference for each project type relative to other types. In the case of projects A, B, C, and D in the foregoing example, if the minimum acceptable score was 0.8 points per $1,000 and the projects were independent, projects B, C, and D would be acceptable within a budget of $400,000 or more.

If the projects were mutually exclusive (alternatives for the same site), project C should be chosen because it dominates A and B, and the incremental score/dollar ratio of D compared with C is only 0.5 points per $1,000. Select non-mutually exclusive projects within a budget limitation in order of their score/dollar ratios until either the available budget is exhausted or the lowest acceptable score per $1,000 is reached. Note that an alternative to this cost-effectiveness approach to project selection is to simply apply the score/dollar ratio to project scores and conduct the selection process as an economic analysis directed to maximizing net present value.

DISCUSSION OF MEASUREMENT TECHNIQUES

As the focal point of this research, great care was taken in selection of evaluation variables and in development of specific measurement techniques for each variable. It soon became apparent that well-developed measurement techniques appropriate to pedestrian facilities were not available for most of the selected variables. Thus, what had been planned as a moderate effort to choose and adapt appropriate techniques became a major development effort.

The previous section described the choice of a unitless scoring system for variable measurements. A scoring technique was developed for each variable ranging from +10 to −10. The maximum positive (desirable) score is +10, a neutral or does-not-apply score is 0, and the largest negative (undesirable) score is −10. Several basic techniques were used to develop a scoring system for each of the selected 36 variables. These basic techniques are described in the following and illustrated with examples from Appendix A.

Types of Measurement Techniques Used

Selection of Value from Table

When this technique is used, the score for the variable is obtained by performing some measurement or observation and looking in a table for the corresponding score. For example, pedestrian density (2.2.3) is scored by determining the average amount of space available for each pedestrian, then looking up the corresponding score in Table 2.

In this case, a practical guide is also given for determining the amount of space per pedestrian. An area can be marked off or may already be available (e.g., concrete pavement separators). Then the number of pedestrians per block can be observed—the sample box given is about 8 ft (2.5 m) square—and the corresponding values obtained.

TABLE 2
PEDESTRIAN DENSITY AND LEVEL OF SERVICE

Number of Persons per 7'10" Square Box	Amount of Space (Square feet* per person)	Level of Service	Score
6 or more	10 or less	Measurable delay numerous conflicts	-10
5	12	Crowded	-6
4	15		-4
3	20	Constrained	0
2	30		4
1	60	Impeded	7
1/2	120		9
1/3	180	Free flow	10
Fewer than 1/23	1400 or more	Empty	6

*To convert square feet to square meters, multiply by 0.0929.

Simple Formula

This scoring technique is illustrated by noise impacts of motor vehicles (2.3.2). In this case both a formula (Eq. 1) and a corresponding graphic scale (Fig. 4) are given for value selection. The appropriate score value is selected after a series of sound readings have been taken and averaged for the facility under evaluation (or estimated for proposed facilities).

This example also illustrates an important measurement feature, the setting of practical end points. Sound levels below 40 db(A) are not often encountered. Because values below this level would not be of added worth to users, a maximum score of +10 is used for all values less than or equal to 40 db(A). Sound levels above 90 db(A) make speech unintelligible and are actually hazardous to health. Therefore, the most undesirable score (−10) is assigned for any sound level greater than or equal to 90 db(A). Assignment of practical end points has three valuable characteristics:

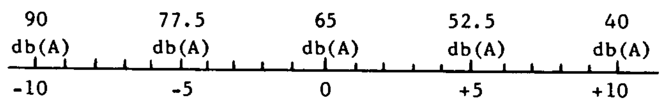
• The resulting smaller range of values allows greater sensitivity in the scoring of different facilities.

• More uniform scoring is frequently made possible because unusual characteristics often appear at the ends of a scale rather than in the middle.

• The occurrence of values beyond the suggested end points alerts the evaluator to unusual conditions that may require special consideration on the part of planners or decision-makers (this situation is noted where appropriate in Appendix A).

Summed Table Values

Figure 5 illustrates the scoring technique used for accident threat concern (2.1.2). This variable appears in the measurement techniques in addition to an accident variable (2.1.1) because utilization of a pedestrian facility is affected both by its actual accident history and by the apparent or perceived threat of accidents. Scoring for this variable is done by checking or circling the value that applies for each component listed in the left-hand column. The value se-



Any noise level over 90 db(A) scores -10
Any noise level under 40 db(A) scores +10

$$\text{Total NOISE SCORE} = -10 + \left[(90 - \text{observed or estimated noise level}) \times 0.4\right]$$

= ________

Figure 4. Noise level scoring.

		Positive		Average		Negative	
Vehicles	Traffic Volume	Low	2	Med	0	High	2
	Traffic Speed	Low	2	Med	0	High	2
	Turning Conflicts	Few	1	Mod	0	Many	1
	One-way Traffic	Yes	1	No	0		--
	Vehicle Mix		--	Mixed	0	High % Trucks Buses	1
Setting	Crosswalks	Marked	1		--	Unmarked	1
	Signalization	Veh and Ped	1	Veh Only	0	None	1
	Sight Distance	Good	1	Mod	0	Poor	1
	Lighting	Good	1	Mod	0	Poor	1

Sum the column values: Positive = ____ Average = 0 Negative = ____

Total ACCIDENT THREAT SCORE is Positive Sum - Negative Sum = ________

Figure 5. Accident threat concern scoring.

lected may be positive, average, or negative. After a value is selected for each component, the positive and negative columns are each added as indicated. The total score is obtained by subtracting the negative sum from the positive sum.

Another measurement feature is illustrated by this example. Note that the components "traffic volume" and "traffic speed" are more heavily weighted (two times more) than any other component. This feature is used to indicate the relative importance of each component when some have a greater effect than others. In this example, up to 40 percent of the sum of the positive points (or negative points) can be contributed by the two named components, whereas the other seven combined can contribute only 60 percent of the respective sums. This weighting indicates the relatively strong effects of vehicle volume and speed on fear of accidents.

Separately Scored Components

Some variables, such as ease of walking (1.1.2), have components with enough special characteristics that each component is separately measured. The scoring range for each component is established separately, then they are combined to produce a total score for the variable being evaluated. The following indicates the individual range of values possible for each of the five components that together are used to score ease of walking:

Component	Scoring Range
Walking surface	−2 to 2
Grade changes	−4 to 2
Continuity	−1 to 2
Signing	−1 to 2
Lighting	−2 to 2
Total EASE OF WALKING SCORE	−10 to 10

Similar to the previous example, different component scores indicate the relative weight of each of the components within the variable.

Weighted Formula

Complex variables such as societal cost of accidents (2.1.1) and travel time (1.1.1) make use of a type of formula that can be adjusted (or weighted) to comparatively measure several facilities. The formula effectively lowers the possible scoring range for each facility proportionately to the magnitude of a selected scaling parameter. For example,

$$\text{Total COST OF ACCIDENT SCORE} = \frac{\left(\begin{array}{c}\text{Present}\\ \text{number of}\\ \text{crossings}\end{array} \times \begin{array}{c}\text{Present}\\ \text{NI rate}\end{array}\right) - \left(\begin{array}{c}\text{Proposed}\\ \text{number of}\\ \text{crossings}\end{array} \times \begin{array}{c}\text{Proposed}\\ \text{NI rate}\end{array}\right) \times 10}{\begin{array}{c}\text{Maximum of above products}\\ \text{for all facilities being compared}\end{array}} = \underline{\qquad}. \quad (2)$$

is used to score the cost of accidents.

In Eq. 2, the numerator represents the difference between the number of accidents before the proposed facility (present), and after the proposed facility (proposed). The number of accidents for each case is obtained by multiplying the number of crossings by the NI rate (net accident involvement rate), computed by using Figure A-9. The feature being illustrated, however, is the denominator. By selecting the maximum number of accidents (either present or proposed), and dividing the difference in accidents for each individual site by this one number, the individual scores will be proportional to the number of accidents for each facility. For example, if Site A had a reduction of 10 accidents and Site B had a reduction of 5 accidents, the scoring for Site B would be only one-half of the score for Site A. If the denominator were 20, the score for A would be +5 and the score for B would be +2.5 (or rounded to +3). This type of formulation is required for some key variables to maintain a level of comparability for the scores of several facilities.

Qualitative Scoring

Some of the variables under consideration in this project were simply too subjective to devise reasonable quantitative measures. For such variables, discussion and some general guidelines are given in Appendix A. The evaluator is then required to assign a value based on judgment and the guidelines given, as illustrated in Figure 6 for adaptability to future urban development plans (4.3.2).

Criteria for Measurement Technique Selection

Several important criteria were used to guide selection of a measurement type for each variable or component. The first was to choose the measurement type that provided the most precise degree of quantification consistent with the data and information available for the item under consideration. The examples given previously indicate the approximate degree of quantification that could be used in a practical measurement technique for each of the sample variables. The second criterion was a deliberate attempt to measure at least one level deeper in precision than had been previously attempted by others. This criterion was adopted to encourage serious consideration by evaluators and others into the meaning and possible importance of all of the variables. The third criterion was an attempt to estimate the relative importance of components within variables, especially where the literature or discussions between the researchers and others indicated probable unequal weighting between components.

Many of the measurement techniques developed during this research extend beyond the usual level of quantification for the selected variables. Thus, use of the developed measurement techniques and future research will verify some of the observations and will also require changes in others. Users of the results of this research are encouraged to make changes to specific measurement techniques whenever such changes seem appropriate. When somewhat different values seem more appropriate to particular groups of evaluators or decision-makers, they should be used. The researchers' primary objective in development of measurement tech-

-10	-5	0	+5	+10
Requires significant modifications to existing land use and development to accommodate the facility		No significant effect on short- or long-term land use and development plans		Enhances desired land use and growth patterns

FUTURE URBAN PLANS SCORE selected = __________.

Figure 6. Urban plan scoring.

niques has been to develop a flexible, quantitative framework for examining and evaluating the many potential impacts of pedestrian facilities. Thus, the techniques will remain useful even if specific values for individual variables or components change over time.

Treatment of Costable Variables

Five of the 36 evaluation variables are costable; each of these first is expressed in dollar units and then scaled to the standard +10 to −10 range. The first of these, and sometimes the largest in absolute magnitude, is motor vehicle travel costs (1.2.1). Vehicle operating and ownership costs are combined with parking costs, and a dollar equivalent of travel time is also included. Total motor vehicle travel costs are transformed to the unitless +10 to −10 scale based on the change from the existing situation.

Two variables in the retail sector, gross retail sales (3.2.1) and displacement or renovation costs (3.2.2), are computed in dollars. Gross retail sales are translated to the unitless +10 to −10 scale based on their average annual percentage increase; displacement and renovation costs are transformed by expressing them as a fraction of the change in gross sales.

The last two costable variables, tax receipts and other revenue (4.2.1) and cost of providing community services (4.3.2), are in the public sector. These are transformed to the unitless scale by dividing by the existing total city budget for the previous year.

Value of Pedestrian Travel Time

Two other variables, pedestrian travel time (1.1.1) and societal costs of accidents (2.1.1) are frequently translated into dollar costs in transportation studies, but this assignment requires judgments to be made of the value to society of an individual's time and the value of reducing accidents, particularly fatalities and serious injuries. This assignment of value is not required by the methodology, but the procedure for imputing values to each of these variables is described subsequently for use by those who desire it.

By the same means that value can be established for savings in automobile travel time (by observing drivers' and passengers' willingness to pay for time savings by using a faster toll road), pedestrian travel may be evaluated by willingness to pay transit fares to save time. However, there are other factors involved in the pedestrian's decision to take transit, particularly comfort and a chance to sit down while traveling. Nevertheless, a few attempts have been made to quantify the value of pedestrian travel time based on willingness to pay transit fares and other models.

Contemporary investigators have concluded that motor vehicle travel time savings for commute trips should be valued at approximately one-half the prevailing wage rate. Thomas (1968) used 0.5 of the hourly wage rate, Ellis (1972) used 0.5, and Webster (1974) used 0.55. Thomas and Thompson (1971) have shown that the value of travel time varies significantly with the magnitude of time saved per trip. Updated values of their findings presented in Andersen et al. (1975) indicate values of 6.4 percent of the wage rate for time savings of less than 5 min, 32.2 percent between 5 and 15 min, and 52.3 percent over 15 min.

A higher value should be assigned to the travel time of pedestrians than that of passenger car occupants. This is because the motorist is in a climate-controlled environment, physically protected and psychologically insulated from the outside. The pedestrian, on the other hand, pays a higher price for travel because of being rained upon, splashed on, exposed to cold, threatened by accidents, and possibly suffering an invasion of his psychological buffer zone. The pedestrian is frequently a purchaser. All of the face-to-face business transacted in a city, except for a limited number of drive-in facilities, is conducted by pedestrians. Because he makes shorter trips than the motorist, a given delay will account for a larger fraction of his total trip, and thus causes more inconvenience. His time is at a different level of perception from that of the motorist and, therefore, has been valued by researchers at two or three times the rate for motorists. The values derived by various investigators are as follows:

Investigator	Ratio of Pedestrian Travel Time Value to Motorist Travel Time Value
Quarmby (1967)	2 to 3
Lisco (1968)	2.8
Ellis (1972)	2
Pushkarev and Zupan (1975)	3.2
Dawson * (1975)	2

* From personal correspondence.

The elderly, handicapped, young, and poor—because they often do not own automobiles—are likely to be overrepresented among pedestrians in suburban and rural locations. These people are often not employed; thus, they probably assign a lower value than average to their time. Hence, a lower value of time could be used for locations other than central business districts. It is also more appropriate to express pedestrian travel time as a value per minute (than per hour as for passenger car time) because pedestrian trips are usually shorter. Even though the time saved is small compared to the total trip time, it is still perceptible to the pedestrian.

The low values associated with small travel time savings for motorists are related to the variability in motor vehicle travel time for a given trip, which is a function of traffic congestion, time of arrival at traffic lights, presence of law enforcement officers, weather, and the time required to find a parking space. Pedestrians, on the other hand, are more in control of their total travel time, inasmuch as stops for rest, sightseeing, shopping, or conversation are usually discretionary. Only delays due to conflicts with vehicles and other pedestrians are usually beyond the control of the pedestrian. Informal observation by project team members shows that pedestrians are acutely aware of and quite irritated by even small delays, such as turning vehicles or escalator queues. Additional evidence is provided by the design guidelines for new elevator installations in office buildings, which frequently specify average waits of no more than 30 sec and average travel times of no more than 60 to 90 sec (Strakosch, 1967) at a considerable cost expense per elevator. Thus, even small changes in pedestrian travel time, particularly those caused by delays rather than changes in walking distance, should be appropriately valued in the methodology.

Considering all of the foregoing, and making the assumptions listed in the following, acceptable values have been developed for pedestrian travel time. The assumptions are as follows:

- The average wage rate is $6.00 per hour for pedestrians in a busy central business district (CBD) and $4.50 per hour for other pedestrians. Webster (1974) used $5.10. Although the national average wage rate for all private production and nonsupervisory nonagricultural workers was $4.49 in June 1975, a substantial fraction of pedestrians in the average CBD hold supervisory or professional positions at higher wage rates.
- Automobile travel time is valued at one-half the prevailing average wage rate, and pedestrian travel time is valued at 2½ times the value for an automobile traveler, or 1¼ times the wage rate.
- The value to an employer of his employees' time is 1½ times the wage rate. This takes into account fringe benefits, training costs, and profit or overhead.
- Delays of up to 5 min are valued at twice the average wage rate.
- Leisure travel and the time of limited-mobility groups is valued at ½ the normal rate.
- Children under the age of 16 have a zero value of travel time, except when the travel decision is made by the parents, in which case other trip characteristics (such as safety) may be more important than travel time.

When calculations are performed using the listed assumptions, the guidelines given in Table 3 are obtained. The reader is, of course, free to use other values, particularly to reflect the local economic conditions.

The total cost of pedestrian travel time is obtained by using the data summarized in Appendix A, Sec. 1.1.1.5. The total travel time (in minutes) for each pedestrian group is multiplied by the corresponding values from Table 3, producing travel time costs for the existing situation and for a proposed facility.

TABLE 3

VALUES OF PEDESTRIAN TRAVEL TIME

Type of Pedestrian (or Trip)	Value of Time (per minute): Central Business Districts	Value of Time (per minute): Other Locations
Commuters, workers on lunch break, or unknown mix	12¢	9¢
People in the course of their work	15¢	11¢
Delays (such as stop lights)	20¢	15¢
Other: Leisure trips, personal business, handicapped, retired, or students	6¢	6¢
Elementary school children	0	0

Societal Cost of Accidents

The approach taken to the evaluation of accident costs is to estimate the total societal costs resulting, directly or indirectly, from motor vehicle accidents involving pedestrians. The monetary values presented here are based on the NHTSA study, "Societal Costs of Motor Vehicle Accidents" (U.S. DOT, 1972). When values from this study are updated to 1975 using a 6 percent cost increase per year, the average societal cost of a fatality is estimated at \$239,000; the average cost of a nonfatal injury (average of disabling and nondisabling) is estimated at \$8,700. These values include medical costs (doctors, medication, special services), legal and court costs, hospital costs, loss of income, employer losses, losses to others, funeral cost (for fatalities), cost of community services, pain and suffering, losses in assets, and inurance administration costs.

Pedestrian accident statistics (from *Accident Facts,* 1975) show that in 1974 there were 8,700 pedestrian fatalities out of an estimated 300,000 pedestrian accidents (about 3 percent). The same source lists 120,000 nonfatal pedestrian injuries (40 percent) that were disabling beyond the day of the accident. However, this does not include nondisabling injuries. It is estimated that some personal injury results from almost all reported pedestrian/vehicle accidents. This conclusion is consistent with an intuitive observation on the probable result of an impact between a 150-lb (70 kg) person and a 4,000-lb (1,800 kg) vehicle. This estimate is also supported by other data in *Accident Facts* (1975) where 40 percent of the injuries in all types of accidents are classed as disabling, and 60 percent of the injuries are classed as nondisabling. Thus, the values given in Table 4 are used in estimating the dollar cost of pedestrian accidents.

By combining the previously developed figures with an estimated probability of a pedestrian accident per person crossing in urban areas of 5×10^{-7} (Prokopy, 1974), an estimated societal pedestrian accident cost of \$0.0078 per person crossing is obtained. This combination provides an estimate of accident costs at an existing or planned pedestrian facility based on the number of pedestrians crossing vehicle lanes. But it also should be noted that complete vehicle/pedestrian separation will result in no such crossings, which will reduce the accident cost for such a facility to zero. Planners who are proposing facilities in an area with reliable historic accident experience data can use the previous data and scale it by the estimated number of pedestrian crossings in the proposed facility divided by the estimated number of pedestrian crossings during the corresponding accident data collection period.

TABLE 4

ACCIDENT FREQUENCY AND COST, BY SEVERITY

Accident Severity	Frequency of Severity per Accident	Cost per Accident by Severity
Fatality	3 per 100	\$239,000
Disabling injury	40 per 100	\$ 8,700
Nondisabling injury	57 per 100	
All	100 per 100	\$ 15,600

A technique was developed to modify the basic pedestrian accident risk figure per crossing (5×10^{-7}) by considering several pedestrian, vehicle, environmental, and traffic control factors. The relative accident risk per crossing for each facility (or each crossing point within the facility if necessary) is developed using Figure 7. For each crossing to be analyzed (one representative crossing may be evaluated if several similar crossings are involved), check off the boxes that apply, then sum the results (using the formula below the table) under both present and planned conditions, obtaining net involvement rates (NI rate) for both situations.

After estimating the present and proposed number of pedestrian crossings per year, the following formulas can be used to obtain a dollar cost figure for each site alternative. Eq. 3 can be used if reliable historic accident data are not available, and Eq. 4 or Eq. 5 can be used if such data are available.

$$\begin{aligned}\text{Annual cost} &= \begin{matrix}\text{Est. no. of}\\ \text{annual accidents}\end{matrix} \times \$15{,}600\\ &= \begin{matrix}\text{Accident risk}\\ \text{per crossing}\end{matrix} \times \begin{matrix}\text{Proposed no.}\\ \text{of crossings}\end{matrix} \times \$15{,}600\\ &= 5 \times 10^{-7} \times \begin{matrix}\text{Proposed}\\ \text{NI rate}\end{matrix} \times \begin{matrix}\text{Proposed no.}\\ \text{of crossings}\end{matrix}\\ &\quad \times \$15{,}600 \qquad (3)\end{aligned}$$

or

$$\begin{aligned}\text{Annual cost} &= \begin{matrix}\text{Historic accident}\\ \text{risk per crossing}\end{matrix} \times \begin{matrix}\text{Proposed}\\ \text{NI rate}\end{matrix}\\ &\quad \times \begin{matrix}\text{Proposed no.}\\ \text{of crossings}\end{matrix} \times \$15{,}600\\ &= \frac{\begin{matrix}\text{Historic no.}\\ \text{of accidents}\end{matrix}}{\begin{matrix}\text{Historic}\\ \text{no. of}\\ \text{crossings}\end{matrix} \times \begin{matrix}\text{Historic}\\ \text{NI rate}\end{matrix}} \times \begin{matrix}\text{Proposed}\\ \text{NI rate}\end{matrix}\\ &\quad \times \begin{matrix}\text{Proposed no.}\\ \text{of crossings}\end{matrix} \times \$15{,}600 \qquad (4)\end{aligned}$$

$$\begin{aligned}&= \begin{matrix}\text{Historic no.}\\ \text{of accidents}\end{matrix} \times \frac{\begin{matrix}\text{Proposed}\\ \text{NI rate}\end{matrix}}{\begin{matrix}\text{Historic}\\ \text{NI rate}\end{matrix}} \times \frac{\begin{matrix}\text{Proposed no.}\\ \text{of crossings}\end{matrix}}{\begin{matrix}\text{Historic no.}\\ \text{of crossings}\end{matrix}}\\ &\quad \times \$15{,}600 \qquad (5)\end{aligned}$$

The estimated accident cost saving of a proposed pedestrian facility equals the present accident cost minus the estimated accident cost of the proposed facility.

DESCRIPTION OF FIELD TEST AND SITE EVALUATIONS

To ensure that the methodology could be applied to real-life situations, the research approach called for testing the methodology at both existing and proposed pedestrian-vehicle separation facilities. Early in the study, for the purpose of sharing preliminary plans and findings, the re-

	Number of:	Rate Decreases				Average		Rate Increases			
PEDESTRIAN	Elderly (≥65)	Few	10	5%	5	10%	0	20%	20	≥30%	40
	Very Young (≤10)	Few	10	1%	5	2%	0	4%	20	≥8%	40
	Alcohol Involved	None	10	Few	5	Mod	0	Mod-High	20	High	40
	Illegal Crossings	None	5	Few	3	Mod	0	Mod-High	10	High	20
VEHICLE	Average Vehicle Volume	Low	5	Mod-Low	3	Mod	0	Mod-High	5	High	20
	Average Vehicle Speed (mph) (kph)	<15 (<25)	5	15-24 (25-39)	3	25-30 (40-49)	0	31-40 (50-65)	10	>40 (>65)	20
	Turning Conflicts	None	5	Few	3	Mod	0	Freq.	5	Many	10
	One-way Traffic		–	Yes	3		–	No	5		–
ENVIRONMENT	Sight Distance	Good	4	Fairly Good	2	Fair	0	Poor	5	Bad	10
	Crossings After Dark (Good Light)	Few	4	Mod-	2	Mod	0		–		
	Crossings After Dark (Poor Light)		–		–	Few	0	Mod	10	Many	20
	Weather	Mild	4	Mod-Mild	2	Mod	0	Mod-Severe	3	Severe	5
CONTROL	Signalization (Presence)			Ped & Veh	10	Veh Only	0	None	20		
	Police Enforcement (Ped Laws)			Heavy	3	Mod	0	Light	3		
	Active Public Education			Yes	2		–	No	2		

Sum the colums as indicated and divide each sum by 100: Decreases ____/100 = ____ Increases ____/100 = ____

Net Involvement Rate is Increase Rate - Decrease Rate ________ + 1 = ________

Figure 7. Accident involvement rate adjustment.

searchers contacted planners who were proposing pedestrian facilities. After a first draft of the measurement techniques was prepared, field trips were made to four sites to apply the techniques. Observations made during these field trips were the basis for substantial modifications to the measurement techniques. Indeed, Sparks Street in Ottawa was the first personal experience the researchers had with a successful mall; it was reassuring to evaluate favorably all of the important features of the mall, based on criteria developed from reading papers and articles on the subject.

Two planned and two existing pedestrian facilities, representing widely different types, were selected for testing the evaluation methodology:

- A pedestrian overpass under construction at Rainier Avenue South and Empire Way South in Seattle, Wash.
- 20th Avenue N.E./Ravenna Park Bridge (Seattle) closure to motor vehicles.
- Sparks Street Mall, Ottawa, Ont.
- Proposed Fulton Mall, Brooklyn, N.Y.

The sites selected for testing range in complexity from the 20th Avenue N.E. Bridge and the Rainier and Empire overpass, which are relatively simple facilities, to the Fulton Mall and the Sparks Street Mall. Thus, the evaluation methodology received a thorough testing over a broad application range with these four facilities. The diversity of these facilities was an important reason for selecting them as examples. Another reason was that the local planners were actively involved with their specific facilities and eager to work with the researchers.

A sound meter, tape measure, camera and film, four tally registers, and notebooks were the only equipment needed for the field studies. Slightly more than one week was required in each city to collect the necessary data. Table 5 outlines the typical field evaluation procedure conducted at each site.

The actual results of applying the methodology to these four sites are given in Appendix B as four separate case studies presented in the chronological order in which the field tests were performed. In each case study, a brief description of the facility site is given followed by the score for each of the 36 evaluation variables (and their com-

TABLE 5

TYPICAL FIELD TEST PROCEDURE

Initial interview with facility planner or manager to:
- Review objectives of the research
- Identify current status of the facility or plan
- Discuss data requirements
- Request introduction or referral to other key personnel.

Field observation
- Thorough familiarization with the site.
- Pedestrian and vehicular traffic counts.
- Detailed inventory of structures, pedestrian and vehicular pathways, street furniture, and so on.
- Application of the measurement techniques.
- Refinement of the measurement techniques based on these observations.

Additional interviews with facility planner or manager as necessary.

Additional field observations as necessary.

Contacts initiated with other municipal agencies for obtaining additional data elements.

Discussions with local merchants.

Final interview with facility planner or manager.

ponents, if applicable), with a discussion of how the score was arrived at and any other relevant comments. For the sake of brevity, most of the worksheets are not reproduced in this section except for a summary score sheet. Therefore, in following the discussion of variables that are evaluated with the use of checklists, it may be helpful to refer to the appropriate scoring worksheet in Appendix A.

Two important results are illustrated by the case studies presented in Appendix B. The first is that evaluations can be performed with little special equipment and with a reasonable number of evaluator man-hours. The second is that the evaluation method has been demonstrated to be applicable to a broad range of pedestrian-oriented facilities in diverse community settings.

DESCRIPTION OF QUESTIONNAIRE AND RESULTS

Purpose of Questionnaire

Probably the most serious difficulty in use of a weighted scoring system is development of an appropriate set of weights for each facility type. This can be a time-consuming process with many complications, especially when a combination of costable, intangible, and qualitative variables is being considered.

Because the difficulties in development of subjective weights were recognized, a questionnaire was devised to (1) determine the practicality of a weighting system and (2) assist in development of guidelines for value estimation. The questionnaire results are presented for the reader to use as a starting point for development of representative weights for his own community.

TABLE 6

SUMMARY OF QUESTIONNAIRE RESULTS

Variable List	Safety/ Movement Facilities		Social/ Commercial Facilities	Safety and Social Facilities		All (12)	All (15)	Combined (27)
	7 State Agencies	3 Urban Agencies	3 Urban Agencies	5 State Agencies	9 Urban Agencies	State Agencies	Urban Agencies	State and Urban Agencies
TRANSPORTATION	25.7%	36.5%	21.9%	30.9%	29.3%	27.0%	29.3%	28.2%
Pedestrians								
(1.1.1)* Travel Time	2.9%	4.7%	1.6%	3.6%	3.3%	2.1%	3.2%	2.7%
(1.1.2) Ease of Walking	2.8	3.6	4.4	2.7	3.0	2.8	3.4	3.1
(1.1.3) Convenience (Access and Availability)	2.7	3.2	5.9	3.8	3.3	3.2	3.8	3.5
(1.1.4) Special Provision for Various Groups	2.2	2.7	2.4	2.8	3.0	2.5	2.8	2.7
Motor Vehicles								
(1.2.1) Motor Vehicle Travel Cost	8.5	5.4	0.4	6.5	5.5	7.7	4.5	6.0
(1.2.2) Use of Automobiles	2.2	3.5	0.8	3.2	2.4	2.6	2.3	2.4
(1.2.3) Signal/Signaling Needs Adjacent to Facility	1.4	3.0	1.3	2.1	2.0	1.7	2.1	1.9
Other Community Transportation								
(1.3.1) Adaptability to Future Transportation Development Plans	1.8	4.4	2.1	3.5	3.3	2.5	3.3	2.9
(1.3.2) Impact on Use of Other Transportation Systems	1.2	6.0	3.0	2.7	3.5	1.9	3.9	3.0

SAFETY/ENVIRONMENT/HEALTH	54.6%	30.2%	24.9%	47.9%	38.9%	52.3%	34.4%	42.6%
Safety								
(2.1.1) Societal Cost of Accidents	23.0%	5.8%	0.3%	17.4%	6.9%	20.7%	5.3%	12.3%
(2.1.2) Accident Threat Concern	11.7	4.5	1.1	5.6	6.3	9.2	4.9	6.9
(2.1.3) Crime Concern	3.6	3.2	2.1	4.2	2.3	3.9	2.4	3.1
(2.1.4) Emergency Access/Medical and Fire Facilities	4.1	2.1	2.5	5.4	3.6	4.7	3.1	3.8
Attractiveness of Surroundings								
(2.2.1) Pedestrian Oriented Environment	5.3	2.9	9.6	2.0	4.7	4.0	5.3	4.8
(2.2.2) Litter Control	0.5	1.3	1.9	1.1	1.1	0.8	1.3	1.1
(2.2.3) Density	1.3	2.1	1.1	2.1	1.4	1.7	1.5	1.5
(2.2.4) Climate Control and Weather Protection	0.8	1.3	2.8	1.8	1.9	1.2	2.0	1.6
Environment/Health								
(2.3.1)* Property Damage Effects of Air Pollution	0.7	0.9	0.7	0.9	1.3	0.8	1.1	1.0
Health, Psychological and Other Effects of Air Pollution	1.0	1.7	0.7	2.6	2.3	1.7	1.9	1.8
(2.3.2) Noise Impacts of Motor Vehicles	1.0	1.5	0.5	2.1	1.8	1.5	1.5	1.5
(2.3.3) Health Effects of Walking (Exercise, Fatigue)	1.0	1.2	0.8	1.9	2.8	1.4	2.1	1.8
(2.3.4) Conservation of Resources	0.6	1.7	0.8	0.8	2.5	0.7	2.0	1.4
RESIDENTIAL/BUSINESS	12.1%	14.9%	27.6%	9.9%	19.9%	11.4%	20.4%	16.3%
Residential Neighborhoods								
(3.1.1) Residential Dislocation	1.4%	4.7%	0.8%	1.5%	2.9%	1.5%	2.8%	2.2%
(3.1.2) Community Pride, Cohesiveness and Social Interaction	2.7	2.3	7.9	1.3	4.9	2.1	5.0	3.7
(3.1.3) Aesthetic Impact, Compatibility with Neighborhood	2.9	2.5	6.1	2.0	2.8	2.6	3.4	3.0
Commercial/Industrial Districts								
(3.2.2) Displacement, Replacement, or Renovation	1.2	1.8	2.0	1.6	1.6	1.4	1.7	1.6
(3.2.1) Profit After Taxes	0.5	0.9	2.2	1.1	2.6	0.8	2.2	1.5
(3.2.3) Ease of Deliveries and Employee Commuting	1.3	1.6	3.3	1.1	2.1	1.2	2.2	1.8
(3.2.4) Attractiveness of Area to Business	2.1	1.1	5.3	1.3	3.0	1.8	3.1	2.5
GOVERNMENT/INSTITUTIONAL	7.6%	18.4%	25.6%	11.3%	11.9%	9.3%	15.9%	12.9%
Planning Process								
(4.1.1) Transportation and Land Use Planning Process	1.1%	3.8%	2.9%	2.8%	2.7%	1.8%	3.0%	2.5%
(4.1.2) Conformance with Requirements and Regulations	0.7	2.0	2.0	2.1	2.9	1.3	2.5	2.0
Indirect Impacts								
(4.2.1) Net Change in Tax Receipts and Other Revenue	0.6	2.0	4.2	1.0	1.1	0.8	1.9	1.4
(4.2.2) Resulting Changes in Employment	0.2	2.0	2.8	0.7	0.9	0.4	11.5	1.0
Community Impacts								
(4.3.1) Community Activities	2.6	1.7	6.5	2.0	2.0	2.4	2.8	2.6
(4.2.3)* Change in Cost of Providing Community Services	1.1	3.0	3.0	1.3	1.3	1.2	2.0	1.6
(4.3.2) Adaptability to Future Urban Development Plans	1.3	3.9	4.2	1.4	1.0	1.4	2.2	1.8
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

*Identifies final variable number assigned in Appendix A.

Results

Review of responses to a preliminary version of the questionnaire and discussions with respondents led the researchers to conclude that the weights developed by respondents varied by facility objective. Two types of pedestrian facility were designated by major purpose. The safety/movement type includes those facilities where severe pedestrian/vehicle conflicts occur or where high pedestrian volumes result in congestion, and the primary intent is to provide safe, unimpeded, pedestrian movement. The social/commercial type includes diverse pedestrian-oriented activities where the major purpose is to provide a safe and enjoyable place for pedestrians to move leisurely and linger, or to shop. Overpasses and pedestrian transit corridors are examples of the first type; malls and small urban parks are examples of the second type.

Questionnaires were sent to (a) 13 state highway or transportation agencies, (b) planning departments or other agencies of 93 city governments (65 of which were known to have pedestrian malls), and (c) 18 other individuals with whom the research team had made contacts. Respondents were requested to identify which type of facility they were considering, or if both types were being considered together. From the 27 completed questionnaires, 10 respondents chose the safety/movement type, 3 chose the social/commercial orientation, and 14 indicated that both types were considered together (combined facilities).

Responses were grouped first by the three facility types then by type of respondent, either as state agencies or as urban agencies (mostly city planners). The results are presented in Table 6, in which Col. 1 lists the 36 variables, by categories and by groups, described in the questionnaire. Because slight modifications were made after the questionnaire was distributed, the current variable number (as in Fig. 1 and App. A) is given for each questionnaire variable.

Cols. 2 through 6 give the average weight for each variable by facility type and respondent type, as well as the sum of the weights within each major category (such as transportation). Cols. 7, 8, and 9 give the average of all state responses, the average of all urban responses, and the average of all responses, respectively.

Comparison of the weight averages by facility type (both state and local values combined) indicated that few significant differences existed between combined facilities and safety/movement-only facilities. Thus it appears that no differentiation need be made between safety facilities and all types of facilities combined when developing a set of weights for community use. However, the questionnaire responses for social/commercial-oriented facilities were significantly different from both safety-only and combined weights. Discussions with other planners indicated similar differences. Thus, when social/commercial objectives are the primary basis for pedestrian facilities, a somewhat different set of weights may be appropriate.

The researchers have developed suggested weights for evaluators to use as a starting point in developing their own weights. Figure 12 gives suggested weights for combined or safety/movement-only facilities; Figure 13 gives suggested weights for social/commercial facilities. The values in Table 6 and Figures 12 and 13 are presented to provide a perspective on the variations and similarities among sets of weights developed for different pedestrian facility objectives.

CHAPTER THREE

INTERPRETATION, APPRAISAL, APPLICATIONS

POTENTIAL APPLICATIONS OF TECHNIQUES DEVELOPED

The primary objective of this research was to provide a comprehensive methodology for evaluating the social, environmental, and economic benefits of pedestrian facility proposals. Benefits and disbenefits are quantified by a set of measurement techniques developed for the 36 variables presented in Appendix A. The over-all evaluation methodology combines analytic measurements of the 36 variables and explicitly stated subjective values (weights) of decision-makers on the relative importance of each variable.

Because many of the variables are subjective in nature (e.g., comfort, attractiveness, noise), the calculation of benefits is performed using a unitless scale of positive and negative values (+10 to −10) for each variable. Positive values correspond to desirable characteristics; negative values indicate undesirable characteristics. Zero values indicate either "does not apply" or "indifference" (neither good nor bad).

Unitless scoring allows comparison of alternatives without the need for assigning dollar values to the many non-economic impacts of pedestrian facilities (and many other public projects). Guidance is also provided for obtaining benefit values in dollars, if required, to allow comparison of pedestrian facilities with other budget expenditures. The primary basic use of the methodology is for evaluation and comparison of proposals for pedestrian facilities, according to the objectives of this research. This application is described in detail in the section "Instructions to Users." Another use of the scoring system is to evaluate existing pedestrian problem locations on a comparative basis. This could be used to indicate the need for improvements on a priority basis. The scoring system may also be used as a design evaluation tool to encourage alterations that will increase the benefits obtained from pedestrian facilities.

Explicit weighting of the relative importance of each variable requires a formalization of preference values for the community. This determination may be made by the decision-maker alone, or may be the result of extensive public participation. Once developed, the explicit use of such weights provides consistent evaluation criteria. These preference weights may be applicable to other public projects as well.

Possibly the greatest advantage of the suggested methodology is that it allows and encourages use of many benefit measures usually excluded from conventional economic analysis. By reflecting community needs and values that are not easily quantified, use of the method may provide adequate justification for projects not defendable previously by economic analysis alone. Thus, objective benefit measurements, coupled with the explicit identification of relative importance values, produce a method that may aid in "preserving and fostering an urban environment drawn to human scale, with values, services, and facilities that respond fully to the needs of various groups that make up the urban community" (OECD, 1969).

INSTRUCTIONS TO USERS

Transportation projects, including pedestrian facilities, should be evaluated as early in the planning and design process as is practical, so that shortcomings can be detected and steps taken to remedy them. The evaluation may then be repeated throughout the planning process as often as new plans are proposed or major changes are made to existing plans. The evaluation procedure may also be used as an aid to the design process by purposely designing facilities that will score high values.

Figure 8 is a flow chart of the steps to be performed for a pedestrian facility evaluation. The diamonds are decision points that allow the user the option of taking shortcuts within the over-all procedure if time or available resources are limited.

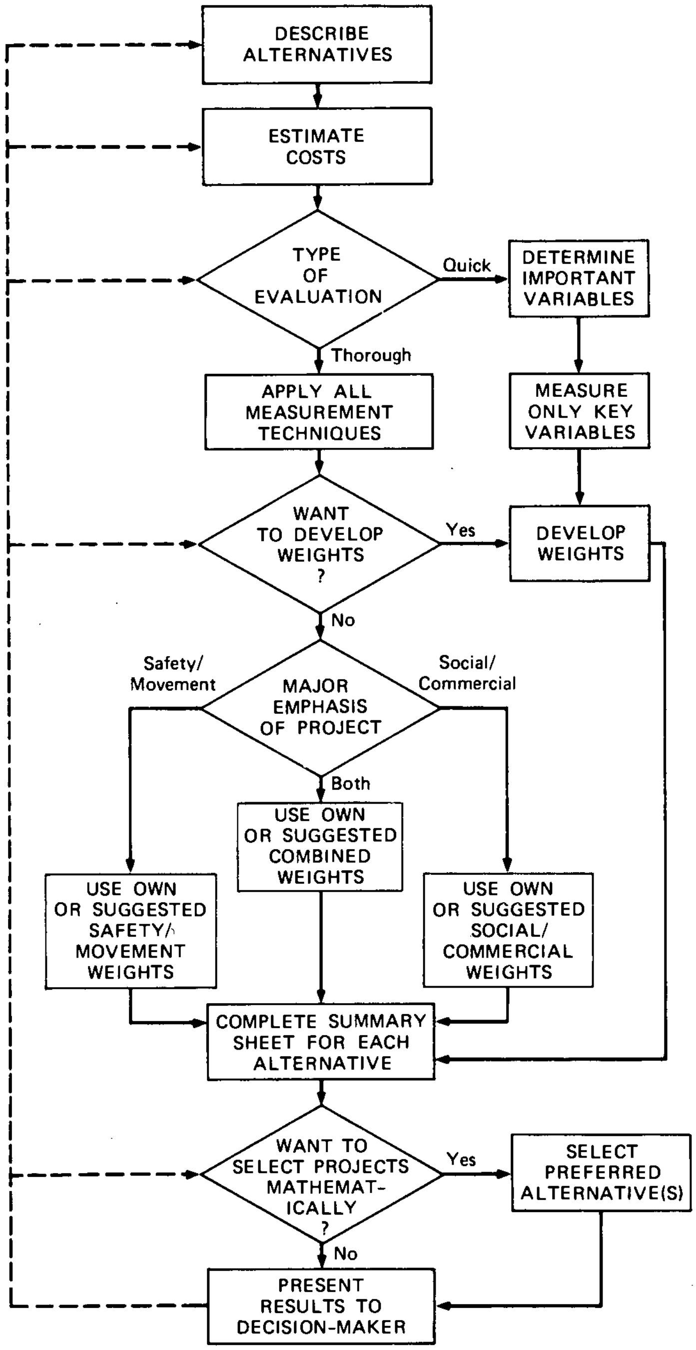


Figure 8. Pedestrian facility evaluation methodology.

Describe Alternatives

The first step of the process is to describe all of the alternative facilities being considered as potential solutions to an existing pedestrian problem. If the study is concerned with only one or a few problem locations or proposed projects, several alternatives representing a range of solutions should be considered and fully described for the evaluation. Location of the proposed facility, its proposed configuration, projected use levels, user profiles, operation characteristics, and any modifications to existing laws or regulations should be specified.

If an entire city-, region-, or statewide plan for pedestrian transportation is being prepared, the specific project alternatives may not always be defined in as much detail as for a single location. In this case, the locations of proposed improvements may be more important than the improvements themselves.

Estimate Costs

An integral component of the process for identifying project alternatives is to estimate costs for the different pedestrian facilities being considered. Table 7 gives all of the major cost categories for implementation and operation of pedestrian-oriented facilities. Make the best estimates

TABLE 7

MAJOR COST COMPONENTS OF PEDESTRIAN FACILITIES

1. Design and architect costs

2. Financing costs and legal fees

3. Site preparation

   - Real estate acquisition
   - Demolition
   - Drainage
   - Grading
   - Utilities relocation
   - Foundation

4. Construction

   - Height, width, and length of facility
   - Length of span (if any)
   - Method of support
   - Enclosures (if any)
   - Materials
   - Construction method used

5. Finishing touches

   - Walkway paving, curbs
   - Lighting
   - Street furniture
   - Amenities
   - Landscaping

6. Operation and maintenance

   - Cleaning
   - Gardening
   - Maintenance and repairs
   - Lighting
   - Security
   - Taxes

possible for the costs associated with each category for the facilities being evaluated. Because the primary purpose of the evaluation in most cases is to compare alternatives, the accuracy of the total cost estimate is not as important as the differences in costs for the various alternatives. This should give encouragement to the planner who is uncertain about the magnitudes of individual cost components. The same observation holds for the benefits determination process: differences between alternatives are more important than the actual score for a particular project proposal. However, if a more detailed cost estimation procedure is desired at this stage in the evaluation process, the reader is directed to Chapter V, "Facility Costs," of *A Manual for Planning Pedestrian Facilities* (Prokopy, 1974), which describes a step-by-step costing approach that is tailored for each particular type of facility.

Assess Benefits

The next step of the methodology is to assess the benefits of the proposed facility. This procedure has been the focal point of the research, and as such will require the greatest effort on the part of the user. However, it is an operation that was previously unavailable, and its existence now will allow more informed public decision-making with complete specification of the impacts of various alternatives.

A total of 36 variables completely specify all primary and secondary impacts of a major facility. However, for quick assessments or for evaluations of very simple facilities, not all of these variables are needed. Therefore, before evaluating any benefits look through the variables discussed in Appendix A and simply cross out those it is not desired to include in this particular analysis. (This is equivalent to assignment of zero benefit to the variables that are eliminated.)

Next apply the instructions for measuring impacts given in Appendix A to all of the variables that remain. Appendix A has been designed to be completely self-contained, so this action is a matter of following the instructions given there, although it may be rather time consuming. Each variable is scored on a uniform +10 to −10 scale. If for any reason it appears that a variable would not apply to a particular facility being evaluated, score zero for that variable.

A project summary sheet (Fig. 9) should be prepared for each alternative under consideration. Record the score for each variable in the "variable score" column on the project summary sheet.

Assign Weights

After the benefits for each proposed alternative have been quantified by using the measurement techniques in Appendix A and properly recorded on the project summary worksheet, it is time to develop weights that reflect the relative priorities of the different impacts. These may be determined directly by the decision-maker (or his representative) based on inputs from groups affected by the facility; or may be selected from the suggested weights developed during this project on the basis of observations, discussions, the researchers' judgment, and the results of a questionnaire distributed to state and local pedestrian facility planners (described in Ch. Two and App. C). These suggested priorities assign a positive weight to every variable, so if some of the variables were eliminated from the analysis in the previous step and the suggested weights are used without modification, it will not be possible for a facility to achieve a perfect score. This can be remedied by proportionately reallocating to other variables the weights of variables that have been eliminated.

Once a set of weights has been developed or selected by the decision-maker, that set can and should be used for all similar projects. The weights need only be revised occasionally to reflect changes in the preferences of the community, decision-makers, or office-holders. This will produce comparable scores for all proposals evaluated. If the weights are changed significantly, resulting scores cannot be directly compared but must be adjusted by the ratio of the differing weights.

Name of Project ______________

Cost initial $______ annual $______

Total Score [ ]

Category	Item	Variable	Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1	Travel Time			
	1.1.2	Ease of Walking			
	1.1.3	Convenience			
	1.1.4	Special Provisions			
1.2 Motor Vehicle Transportation	1.2.1	Vehicle Travel Costs			
	1.2.2	Use of Automobiles			
	1.2.3	Signal/Signing Needs			
1.3 Other Community Transportation	1.3.1	Future Transportation Plans			
	1.3.2	Existing Transportation			
2.1 Safety	2.1.1	Cost of Accidents			
	2.1.2	Accident Threat			
	2.1.3	Crime Concern			
	2.1.4	Emergency			
2.2 Attractiveness of Surroundings	2.2.1	Pedestrian Oriented Environment			
	2.2.2	Litter Control			
	2.2.3	Density			
	2.2.4	Climate Control & Weather Protection			
2.3 Environment/ Health	2.3.1	Air Pollution			
	2.3.2	Noise			
	2.3.3	Health			
	2.3.4	Conservation			
3.1 Residential Neighborhoods	3.1.1	Residential Dislocation			
	3.1.2	Community Pride & Inter-action			
	3.1.3	Aesthetics & Compatibility			
3.2 Commercial/ Industrial Districts	3.2.1	Retail Sales			
	3.2.2	Displacement or Renovation			
	3.2.3	Deliveries & Commuting			
	3.2.4	Attractiveness to Business			
4.1 Planning Process	4.1.1	Public Participation			
	4.1.2	Requirements & Regulations			
4.2 Economic Impacts	4.2.1	Tax Receipts			
	4.2.2	Employment			
	4.2.3	Community Services			
4.3 Community Impacts	4.3.1	Community Activities			
	4.3.2	Future Urban Plans			
	4.3.3	Construction			

Figure 9. Project summary sheet.

Direct Determination

The purpose of developing a set of weights is to incorporate the decision-maker's perception of the relative importance of changes in degree of impact of the evaluation variables used in the methodology. The procedure is to assign a separate set of values expressed in percentages for each of the three levels of impacts (categories, groups, and variables), the sum of each level being 100 percent. When the percentage values assigned to the three levels for a particular variable are multiplied together, the resulting product indicates the relative importance of that factor in the total evaluation process. For example, if values of 20 percent, 40 percent, and 30 percent are assigned to the headings transportation (category), pedestrians (group), and travel time (variable), respectively, by multiplying ($0.2 \times 0.4 \times 0.3 = 0.024$), a value of 2.4 percent is obtained as the relative weight of the variable "travel time" (1.1.1).

The following procedure is suggested to assist the reader in developing a set of relative values:

1. Refer to Figure 10, which is a worksheet for use in assigning a set of values as previously described.
2. Review Appendix A and the results of the measurements to become familiar with the categories and descriptions of the variables as listed on the worksheet (Fig. 10).
3. Rank order (1, 2, 3, etc.) each of the three levels of impacts. First rank order the major categories, then the groups within each major category, and finally each subset of individual variables. This may be easier than attempting to assign actual values on the first attempt.
4. Repeat Step 3, refining the rank ordering into percentages. This is shown in Figure 11, a sample completed worksheet. Zero is a legitimate percentage value to use at any level (e.g., signal/signing needs adjacent to facility in Fig. 11). Zeroes should also be assigned to the variables that were previously eliminated from the evaluation.
5. Review the assigned weights and revise them if desired. Check the arithmetic to see that each sum adds to 100 percent.
6. Multiply the three level weights together to determine and compare the resulting relative weight of each individual factor. Round the percentages to the nearest tenth (e.g., $25\% \times 35\% \times 30\% = 0.02625$ is rounded to 2.6%).
7. If desired, it is possible to allow different constituencies to express their individual preferences. Have a representative of each group indicate its preferences on a copy of Figure 10. These multiple results may then be used in one of three ways:

   (a) If equal importance is applied to each of the groups completing the worksheet, simply take the average weight for each variable from the last column of the worksheets prepared by the groups as the composite weight.

   (b) If some groups are more important, vocal, or influential than others, assign weights (adding up to 100%) indicating the relative importance of the groups. Then take the weighted average for each variable from the last column of the completed worksheets as the composite weight.

   (c) If the different groups have completely different sets of values, a composite weighting would not reflect the variance. For example, if values assigned to safety were 40 percent and 2 percent, the average (21 percent) is a compromise that does not indicate how much safety is valued by the first group or how little it is valued by the other. In these cases, it is not necessary to combine the community's preferences at this point. Instead, perform a separate evaluation of the alternatives for each group. Each evaluation would use the same objective measurements, but the weights will be different. Present the objective measurements, each group's subjective weights, and final score for the proposed project alternatives (a) to the community and to the decision-maker or (b) to the community and allow the decision-maker to achieve a compromise based on public meetings, private meetings, and his own judgment.
8. Transfer the results from the last column of the weight assignment worksheet (Fig. 10) to the second column of the project summary sheet (Fig. 9).

Use of Suggested Weights

If a quick evaluation is being made, it is possible to apply a set of weights developed by the researchers, rather than the reader. One advantage of these standard weights (other than the obvious savings of time and effort) is that evaluations performed in different cities or states will be directly comparable. Even if the reader is developing weights to represent community preference, an examination of the suggested weights might provide insights, particularly on the difference in emphasis between facility types.

Two types of pedestrian facilities have been identified based on their major purpose. The *safety/movement* type includes those facilities where severe pedestrian/vehicle conflicts occur or where high pedestrian volumes result in congestion, and the primary intent is to provide safe unimpeded pedestrian movement. The *social/commercial* type includes planned activity pedestrianization where the major purpose is to provide a safe and enjoyable place for pedestrians to move leisurely and stop. Overpasses are examples of the first type; malls are examples of the second type.

Suggested weights for safety or movement facilities are shown in Figure 12. Figure 13 shows the recommended weights for social or commercial facilities. If the evaluation combines both project types, the weights given in Figure 12 are used. Transfer the weights from the final column of the appropriate figure to the second column of the project summary worksheet (Fig. 9).

Summary Step

At this point in the evaluation, the project summary sheet (Fig. 9) should have the first two columns (variable score and variable weighting) completed. The sheet should also indicate the name of the project and the initial construction and annual operating costs for each alternative considered. The third column (weighted score) is completed by multiplying the objective measurement score for each variable (first column) by the weight (second column) in percent (not decimal form). The total weighted score of the benefits for a pedestrian facility is simply the sum of all the individual weighted scores. Use of percent values as indi-

Types of Facilities Being Evaluated

- ☐ Safety/Movement Only
- ☐ Social/Commercial Only
- ☐ Both Types Together

Rank Order	Percent-Ages		Levels of Impacts	Weight of Each Variable

___/___% I. Transportation

  ___/___% Pedestrians

    ___/___% Travel Time ______%
    ___/___% Ease of Walking ______
    ___/___% Convenience (Access and Availability) ______
    ___/___% Special Provision for Various Groups ______
    (100%)

  ___/___% Motor Vehicles

    ___/___% Motor Vehicle Travel Costs ______
    ___/___% Use of Automobiles ______
    ___/___% Signal/Signing Needs Adjacent to Facility ______
    (100%)

  ___/___% Other Community Transportation

    ___/___% Adaptability to Future Transportation Development Plans ______
    ___/___% Impact on Use of Other Transportation Systems ______
  (100%) (100%)

___/___% II. Safety/Environment/Health

  ___/___% Safety

    ___/___% Societal Cost of Accidents ______
    ___/___% Accident Threat Concern ______
    ___/___% Crime ______
    ___/___% Emergency Access/Medical and Fire Facilities ______
    (100%)

  ___/___% Attractiveness of Surroundings

    ___/___% Pedestrian Oriented Environment ______
    ___/___% Litter Control ______
    ___/___% Density ______
    ___/___% Climate Control and Weather Protection ______
    (100%)

  ___/___% Environment/Health

    ___/___% Effects of Air Pollution ______
    ___/___% Noise Impacts of Motor Vehicles ______
    ___/___% Health Effects of Walking (exercise, fatigue, etc.) ______
    ___/___% Conservation of Resources ______
  (100%) (100%)

___/___% III. Residential/Business

  ___/___% Residential Neighborhoods

    ___/___% Residential Dislocation ______
    ___/___% Community Pride, Cohesiveness, and Social Interaction ______
    ___/___% Aesthetic Impact, Compatibility with Neighborhood ______
    (100%)

  ___/___% Commercial/Industrial Districts

    ___/___% Gross Retail Sales ______
    ___/___% Displacement or Renovation ______
    ___/___% Ease of Deliveries and Employee Commuting ______
    ___/___% Attractiveness of Area to Business ______
3 (100%) (100%)

___/___% IV. Government/Institutional

  ___/___% Transportation and Land Use Planning Process

    ___/___% Public Participation in the Planning Process ______
    ___/___% Conformance with Requirements and Regulations ______
    (100%)

  ___/___% Economic Impacts

    ___/___% Net Change in Tax Receipts and Other Revenue ______
    ___/___% Resulting Changes in Employment ______
    ___/___% Change in Cost of Providing Community Services ______
    (100%)

  ___/___% Community Impacts

    ___/___% Community Activities ______
    ___/___% Adaptability to Future Urban Development Plans ______
    ___/___% Construction Period ______
(100%) (100%) (100%) (100%)

Figure 10. Worksheet.

Types of Facilities Being Evaluated
☐ Safety/Movement Only
☐ Social/Commercial Only
☐ Both Types Together

Rank Percent-Order Ages		Levels of Impacts			Weight of Each Variable
2 /20%	I.	Transportation			
		1 /40%	Pedestrians		
			1 /30%	Travel Time	2.4%
			4 /20%	Ease of Walking	1.6
			3 /20%	Convenience (Access and Availability)	1.6
			2 /30%	Special Provision for Various Groups	2.4
			(100%)		
		2 /40%	Motor Vehicles		
			1 /90%	Motor Vehicle Travel Costs	7.2
			2 /10%	Use of Automobiles	.8
			3 /0%	Signal/Signing Needs Adjacent to Facility	0
			(100%)		
		3 /20%	Other Community Transportation		
			1 /80%	Adaptability to Future Transportation Development Plans	3.2
			2 /20%	Impact on Use of Other Transportation Systems	.8
		(100%)	(100%)		
1 /60%	II.	Safety/Environment/Health			
		1 /80%	Safety		
			1 /70%	Societal Cost of Accidents	33.6
			2 /10%	Accident Threat Concern	4.8
			3 /10%	Crime	4.8
			4 /10%	Emergency Access/Medical and Fire Facilities	4.8
			(100%)		
		3 /10%	Attractiveness of Surroundings		
			2 /30%	Pedestrian Oriented Environment	1.8
			4 /10%	Litter Control	.6
			1 /40%	Density	2.4
			3 /20%	Climate Control and Weather Protection	1.2
			(100%)		
		2 /10%	Environment/Health		
			1 /40%	Effects of Air Pollution	2.4
			3 /30%	Noise Impacts of Motor Vehicles	1.8
			2 /20%	Health Effects of Walking (exercise, fatigue, etc.)	1.2
			4 /10%	Conservation of Resources	.6
		(100%)	(100%)		
3 /10%	III.	Residential/Business			
		1 /50%	Residential Neighborhoods		
			2 /20%	Residential Dislocation	1.0
			3 /30%	Community Pride, Cohesiveness, and Social Interaction	1.5
			1 /50%	Aesthetic Impact, Compatibility with Neighborhood	2.5
			(100%)		
		2 /50%	Commercial/Industrial Districts		
			1 /50%	Gross Retail Sales	2.5
			2 /20%	Displacement or Renovation	1.0
			4 /10%	Ease of Deliveries and Employee Commuting	.5
			3 /20%	Attractiveness of Area to Business	1.0
	3	(100%)	(100%)		
4 /10%	IV.	Government/Institutional			
		2 /20%	Transportation and Land Use Planning Process		
			1 /60%	Public Participation in the Planning Process	1.2
			2 /40%	Conformance with Requirements and Regulations	.8
			(100%)		
		3 /10%	Economic Impacts		
			1 /50%	Net Change in Tax Receipts and Other Revenue	.5
			3 /20%	Resulting Changes in Employment	.2
			2 /30%	Change in Cost of Providing Community Services	.3
			(100%)		
		1 /70%	Community Impacts		
			1 /60%	Community Activities	4.2
			3 /20%	Adaptability to Future Urban Development Plans	1.4
			2 /20%	Construction Period	1.4
(100%)		(100%)	(100%)		(100%)

Figure 11. Sample completed worksheet.

Name of Project ________

Cost initial$ ______ annual $ ______

Total Score [ ]

			Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1	Travel Time		2.5 %	
	1.1.2	Ease of Walking		3.0	
	1.1.3	Convenience		3.5	
	1.1.4	Special Provisions		2.5	
1.2 Motor Vehicle Transportation	1.2.1	Vehicle Travel Costs		6.0	
	1.2.2	Use of Automobiles		2.5	
	1.2.3	Signal/Signing Needs		2.0	
1.3 Other Community Transportation	1.3.1	Future Transportation Plans		3.0	
	1.3.2	Existing Transportation		3.0	
2.1 Safety	2.1.1	Cost of Accidents		12.0	
	2.1.2	Accident Threat		7.0	
	2.1.3	Crime Concern		3.0	
	2.1.4	Emergency		3.5	
2.2 Attractiveness of Surroundings	2.2.1	Pedestrian Oriented Environment		5.0	
	2.2.2	Litter Control		1.0	
	2.2.3	Density		1.5	
	2.2.4	Climate Control & Weather Protection		1.5	
2.3 Environment/ Health	2.3.1	Air Pollution		3.0	
	2.3.2	Noise		1.5	
	2.3.3	Health		1.5	
	2.3.4	Conservation		1.5	
3.1 Residential Neighborhoods	3.1.1	Residential Dislocation		2.0	
	3.1.2	Community Pride & Interaction		3.5	
	3.1.3	Aesthetics & Compatibility		3.0	
3.2 Commercial/ Industrial Districts	3.2.1	Retail Sales		1.5	
	3.2.2	Displacement or Renovation		1.5	
	3.2.3	Deliveries & Commuting		2.0	
	3.2.4	Attractiveness to Business		2.5	
4.1 Planning Process	4.1.1	Public Participation		2.5	
	4.1.2	Requirements & Regulations		2.0	
4.2 Economic Impacts	4.2.1	Tax Receipts		1.5	
	4.2.2	Employment		1.0	
	4.2.3	Community Services		1.5	
4.3 Community Impacts	4.3.1	Community Activities		2.5	
	4.3.2	Future Urban Plans		2.0	
	4.3.3	Construction		1.0	

Figure 12. Suggested safety/movement or combined weights.

Name of Project ________

Cost initial$______ annual $______

Total Score [ ]

Category	No.	Variable	Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1	Travel Time		1.5 %	
	1.1.2	Ease of Walking		2.5	
	1.1.3	Convenience		3.5	
	1.1.4	Special Provisions		3.0	
1.2 Motor Vehicle Transportation	1.2.1	Vehicle Travel Costs		0.5	
	1.2.2	Use of Automobiles		1.0	
	1.2.3	Signal/Signing Needs		1.5	
1.3 Other Community Transportation	1.3.1	Future Transportation Plans		1.5	
	1.3.2	Existing Transportation		3.0	
2.1 Safety	2.1.1	Cost of Accidents		3.0	
	2.1.2	Accident Threat		2.0	
	2.1.3	Crime Concern		3.0	
	2.1.4	Emergency		3.0	
2.2 Attractiveness of Surroundings	2.2.1	Pedestrian Oriented Environment		10.0	
	2.2.2	Litter Control		2.0	
	2.2.3	Density		2.0	
	2.2.4	Climate Control & Weather Protection		2.0	
2.3 Environment/ Health	2.3.1	Air Pollution		4.0	
	2.3.2	Noise		2.5	
	2.3.3	Health		2.5	
	2.3.4	Conservation		2.0	
3.1 Residential Neighborhoods	3.1.1	Residential Dislocation		2.0	
	3.1.2	Community Pride & Inter- action		6.0	
	3.1.3	Aesthetics & Compatibility		4.0	
3.2 Commercial/ Industrial Districts	3.2.1	Retail Sales		2.5	
	3.2.2	Displacement or Renovation		2.5	
	3.2.3	Deliveries & Commuting		2.5	
	3.2.4	Attractiveness to Business		4.5	
4.1 Planning Process	4.1.1	Public Participation		3.5	
	4.1.2	Requirements & Regulations		1.0	
4.2 Economic Impacts	4.2.1	Tax Receipts		3.5	
	4.2.2	Employment		2.0	
	4.2.3	Community Services		1.0	
4.3 Community Impacts	4.3.1	Community Activities		5.0	
	4.3.2	Future Urban Plans		2.5	
	4.3.3	Construction		1.5	

Figure 13. Suggested social/commercial weights.

Name of Project SPARKS STREET MALL

Cost initial $1,500,000 annual $34,800

+391 Total Score

			Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1	Travel Time	+1	1.5 %	2
	1.1.2	Ease of Walking	+7	2.5	18
	1.1.3	Convenience	+4	3.5	14
	1.1.4	Special Provisions	0	3.0	0
1.2 Motor Vehicle Transportation	1.2.1	Vehicle Travel Costs	+1	0.5	1
	1.2.2	Use of Automobiles	+1	1.0	1
	1.2.3	Signal/Signing Needs	0	1.5	0
1.3 Other Community Transportation	1.3.1	Future Transportation Plans	+5	1.5	8
	1.3.2	Existing Transportation	0	3.0	0
2.1 Safety	2.1.1	Cost of Accidents	+6	3.0	18
	2.1.2	Accident Threat	+8	2.0	16
	2.1.3	Crime Concern	+8	3.0	24
	2.1.4	Emergency	+6	3.0	18
2.2 Attractiveness of Surroundings	2.2.1	Pedestrian Oriented Environment	+7	10.0	70
	2.2.2	Litter Control	0	2.0	0
	2.2.3	Density	-4	2.0	-8
	2.2.4	Climate Control & Weather Protection	-6	2.0	-12
2.3 Environment/ Health	2.3.1	Air Pollution	+5	4.0	20
	2.3.2	Noise	+4	2.5	10
	2.3.3	Health	+4	2.5	10
	2.3.4	Conservation	+10	2.0	20
3.1 Residential Neighborhoods	3.1.1	Residential Dislocation	0	2.0	0
	3.1.2	Community Pride & Inter-action	+4	6.0	24
	3.1.3	Aesthetics & Compatibility	0	4.0	0
3.2 Commercial/ Industrial Districts	3.2.1	Retail Sales	+4	2.5	10
	3.2.2	Displacement or Renovation	+1	2.5	3
	3.2.3	Deliveries & Commuting	-5	2.5	-13
	3.2.4	Attractiveness to Business	+6	4.5	27
4.1 Planning Process	4.1.1	Public Participation	+6	3.5	21
	4.1.2	Requirements & Regulations	+10	1.0	10
4.2 Economic Impacts	4.2.1	Tax Receipts	0	3.5	0
	4.2.2	Employment	+2	2.0	4
	4.2.3	Community Services	0	1.0	0
4.3 Community Impacts	4.3.1	Community Activities	+10	5.0	50
	4.3.2	Future Urban Plans	+10	2.5	25
	4.3.3	Construction	0	1.5	0

Figure 14. Sample project summary sheet for the Sparks Street Mall.

cated will result in a "total score" for the facility between +1000 and −1000, which is more suitable for comparing projects than the +10 to −10 scale appropriate for measuring individual benefit variables.

This completes the project evaluation. A completed project summary sheet for each proposed alternative summarizes all of the important information about the impacts of the project. Priorities for a small set of alternatives or a single go/no-go decision may be made directly. If a large number of alternatives is being investigated or a budget allocation programming is being performed, the reader may wish to follow the discussion of "Decision Rules for Project Selection" (Ch. Two).

Figure 14 is a sample project summary sheet for the Sparks Street Mall. Summary sheets for the other three case studies are included in Appendix B.

Conversion to Dollar Values (Optional)

If it becomes desirable to estimate a dollar value for all benefits (for example, to compare with other types of public projects), the following procedure can be used. Record the computed dollar values from Appendix A before conversion to unitless scoring for motor vehicle travel costs (1.2.1), gross retail sales (3.2.1), renovation costs (3.2.2), tax receipts and other revenue (4.2.1), and cost of providing community services (4.3.2). Then use the sections "Value of Pedestrian Travel Time" and "Societal Cost of Accidents" in Chapter Two to compute dollar value estimates for those two variables (1.1.1 and 2.1.1, respectively).

The remaining 29 variables are not readily quantified in dollars, but proxy dollar values can be established by deriving a value per point from the costable variables. For example, if motor vehicle travel costs (1.2.1) scored +10 points, and was weighted at 15 percent, the weighted score would be 150 points (10 points × 15%). If the dollar value was $15,000, each weighted scoring point would be estimated at $100. This procedure should be followed for all seven of the costable variables and an average point value should be computed to apply to the noncostable variables. For example, if the average point value was $100, and if accident threat concern (2.1.2) scored +5 points and was weighted at 6 percent, its weighted score would be 30 points (5 points × 6%), and its proxy dollar value would be $3,000 ($100 × 30 weighted points). A total project dollar benefit value can then be obtained for this example by adding the products of the average point value times the weighted scoring point for each noncostable variable to the dollar values of the seven costable variables identified in the previous paragraph.

An alternative approach is to calculate the average point value of similar types of pedestrian facilities, either approved for construction or already constructed, using their total cost as a rough measure of their benefits. (Such costs should be escalated to current price levels in the case of completed facilities.) A point value obtained this way would provide a lower bound on what the community has demonstrated it is willing to pay per point for such facilities. Higher values for benefit point can be used if benefits are judged by the community to have exceeded costs for completed projects.

CHAPTER FOUR

CONCLUSIONS AND SUGGESTED RESEARCH

CONCLUSIONS

The primary objective of this research, the development of a comprehensive methodology for evaluating the social, environmental, and economic impacts of proposals for pedestrian facilities, has been achieved. Measurement techniques were developed for 36 variables that quantify all significant direct and indirect benefits and disbenefits of facilities separating pedestrians and vehicles. Hundreds of individual parameters are examined as components or characteristics of the 36 measurement variables in Appendix A. The over-all methodology combines analytic measurement of these variables with weights selected by the decision-maker on the relative importance of each variable. The result is a comprehensive and consistent, yet flexible and responsive tool for traffic engineers, planners, developers, architects, evaluators, political decision-makers, lobbyists, and community civic groups.

The over-all methodology and the extensive range of measured parameters provide a broad perspective on the design of pedestrian facilities. The inclusion and quantification of many subjective variables reflect the presence of needs and desires within the community that are usually excluded from conventional economic analyses. Thus, even though the methodology increases the number of impacts considered by the decision-maker, it makes the decision task easier by the use of explicit rather than implied evaluation factors.

SUGGESTIONS FOR FUTURE RESEARCH

Further Refinement of the Measurement Techniques

This research has attempted to develop a comprehensive methodology that evaluates all primary and secondary impacts of a wide variety of pedestrian-oriented facilities. The variables and their components were developed in their present form by the research team from minimal existing information in many cases. Inasmuch as the techniques have been tested only at four locations and only by the researchers responsible for their development, further refinement of the measurement techniques will undoubtedly occur when they are employed in future applications. Development and extension of this research should occur during the first few years that the methodology is used in the design and evaluation phases of a variety of projects that separate pedestrians from vehicles. It certainly would be desirable to collect all of these experiences at some future time.

It is believed that further refinement of the measurement structure, the addition or deletion of variable characteristics and components, the technique for evaluating each component characteristic, the internal weighting of the various components, and the phrasing of the narrative and graphics could be embarked upon as a separate research study for almost any of the 36 evaluation variables. Some variables deserve a higher priority in this reevaluation and reformulation process than others, based on the current state of measurement techniques and the consequent uncertainties that are encountered in formulating them. These priorities are discussed in the following paragraphs.

For most of the 36 variables, the important components that characterize the particular impact have been identified, but the four case studies were insufficient to perfect the relative weightings given to the various components. The implicit weights for each variable were determined as best estimates, based on reading the literature, discussions with facility planners and designers, the four case studies, and personal experience as pedestrians. In some cases, though, assignment of a particular set of weights was not justified, and all of the characteristics were assembled into a checklist, implicitly assigning them all equal weight. The following seven variables should be examined more thoroughly in an effort to develop more precise internal weights of their components:

- 1.1.2 Ease of walking.
- 1.1.4 Special provision for various groups.
- 2.2.1 Pedestrian-oriented environment.
- 2.2.3 Health effects of walking.
- 3.1.2 Community pride, cohesiveness, and social interaction.
- 3.1.3 Aesthetic impact, and compatibility with neighborhood.
- 3.3.4 Attractiveness of area to business.

In view of the experience gained in the conduct of this project, six additional variables are believed to be candidates for more comprehensive study and reformulation. These variables deserve more concentrated attention than was possible in this study because little previous research had been done in their particular domain. These six variables are described as follows:

1. Impact on use of existing transportation systems (1.3.2) provides the user with a chart for recording changes in the type of use and required modifications to existing transportation modes, but the analyst must use his own judgment to convert the entries on this table to a final score. The impacts of proposed pedestrian facilities on other transportation systems are poorly understood. In anticipation of ever-increasing emphasis on energy conservation, on efforts to decrease urban air, water, and noise pollution, and on citizen demands for less congestion, an effective and comprehensive evaluation of these multiple impacts is expected to become increasingly important to the urban planner.
2. For societal cost of accidents (2.1.1), greater accuracy is needed in predicting the frequency of pedestrian accidents, basing the predictions on facility design, use, and environmental characteristics. Also, an effort should be made to predict the severity of injuries and the probability of a fatal pedestrian accident, given these same parameters.
3. Additionally, research is needed to more accurately predict the occurrence and effects of criminal incidents (crime, 2.1.3), given information about the design and operation of the pedestrian facility and information about social content of the surrounding community.
4. A major component of the litter control (2.2.2) variable is the cleanliness index developed by the Urban Institute to evaluate street and alley litter conditions. This work should be extended to produce photographs illustrating the levels of cleanliness of pedestrian facilities (such as malls and overpasses).
5. For residential dislocation (3.1.1), further research should be directed to better understanding the social and psychological impacts to individuals who are relocated, and how social assistance may be designed to meet these needs.
6. Finally, a better means is needed for predicting and measuring how a pedestrian facility affects the level of community activities (4.3.1).

Further study on any one of the 13 variables mentioned is believed to be a candidate subject for university research, and particularly well suited for dissertation or thesis topics.

Extensions of the Research Project

In addition to refinement of the particular measurement techniques previously mentioned, further research to extend the presented methodology would prove helpful to pedestrian facility planners and evaluators. These specific research topics are identified in the following.

First, this research report could be supplemented with the use of a well-designed visual display using sophisticated graphics techniques. A narrated slide show or a moving picture might be the best format. The presentation could convey the information presented in this report rapidly and effectively to decision-makers, community groups, and planners.

An objective of this research was to identify comprehensive primary and secondary impacts of a wide range of pedestrian facilities to planners and members of the community alike. Thirty-six variables have been chosen to completely describe all of the benefits and disbenefits of a complex facility such as a large mall or an extensive auto-free zone. However, fewer variables chosen from the 36 are required to adequately describe the impacts of simpler facilities. The researchers have attempted to provide a widely useful methodology by suggesting that different weights be used for what are designated as "safety/movement" and "social/commercial" types of facilities. However, this is a compromise; although a unified and comprehensive evaluation methodology is desirable for citywide or regional budget allocation, methodologies designed for evaluating specific facility types might be more useful in situations where only certain types of facilities are being considered for given applications.

Thus, the second suggestion for extending the study would be to write several handbooks, each of which would describe an evaluation methodology tailored for a specific type of facility.

These two suggested extensions to the research could be performed with a relatively modest budget because they involve presenting, in different formats, research that has already been completed.

The third suggested extension to the present research is more in the nature of a follow-on project; its purpose would be to develop a broad set of pedestrian facility design concepts and selection criteria related to facility purpose and stakeholder interests. Facilities intentionally designed to achieve a high rating are likely to be well received in the community. With generally accepted pedestrian design criteria, cost savings would be realized in materials, assembly, and construction if modular, multipurpose components would be developed to meet variable needs. The need is for a system that will help to optimize tradeoffs. Additionally, model ordinances and building codes could be developed for use by cities desiring to guarantee that future public works and private developments would be planned with the pedestrian user in mind.

A related extension of the research would be to use the evaluation methodology as a basis for developing warrants for pedestrian facilities. Not all of the measurement techniques would be needed for this application because many of them are more applicable to evaluating proposed changes, rather than quantification of existing problems.

Other Related Research Topics

Other suggestions for research in areas related to this project, but not direct extensions of this study, are described in the following.

The current research project was undertaken because pedestrians and motor vehicles usually cannot safely or comfortably coexist on land that is intensively used for transportation or other commercial purposes. An increasingly attractive alternative to separating pedestrian and motor vehicle traffic is to eliminate one of them, within carefully defined borders. One solution that is growing more socially acceptable and environmentally sound is to restrict the operation of motor vehicles in central cities. The means for accomplishing this have been researched extensively and rough estimates made of the impacts of such actions. However, no definitive study has been made on comparative costs to a city and its residents of supporting and operating an urban transport system centered around the automobile. The results of this study might prove to be very enlightening, for if the results show from a broad social perspective that the automobile is more expensive to maintain and operate than the alternatives, cities would be able to more completely compute the financial and other advantages that would accrue by eliminating automobiles from congested city centers.

An objective of this research project has been to assess a comprehensive range of social, economic, and environmental impacts of proposed pedestrian facilities and to organize these impacts in a fashion that enables decision-makers to act with full knowledge of the implications of the various alternatives. Further research directed toward developing a rational decision-making strategy for local governments and others might bring the process further into the public eye. If more knowledge were available on how decisions may be guided by informed public inputs, community civic associations could learn to make themselves more effective, and presumably everyone would benefit as a result.

One final suggested research project is the development of an effective pedestrian counter. The researchers have heard suggestions for this research at professional society meetings for some time, but the need became clear when pedestrians were counted by researchers holding a tally register in each hand. The solution is certainly not straightforward, yet we believe that technological solutions are probably feasible for the perfection of a fast and accurate counter through a directed research project.

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APPENDIX A

MEASUREMENT TECHNIQUES FOR EVALUATING PEDESTRIAN FACILITY VARIABLES

INTRODUCTION

This workbook presents measurement techniques for evaluating each of the 36 variables identified during the research for NCHRP Project 20-10. The Pedestrian Facility Evaluation Index, serving as both an index and an outline, lists the impacts of pedestrian facilities in four major categories: Transportation, Safety/Environment/Health, Residential/Business, and Government and Institutions. These categories are subdivided into groups of impacts, such as pedestrians, motor vehicles, and other community transportation. The groups consist of individual impacts called variables, which are the major focus of benefit measurements. For example, the variables for the group "pedestrians" are travel time (1.1.1), ease of walking (1.1.2), convenience (1.1.3), and special provisions (1.1.4).

A scoring procedure has been developed for each of the 36 variables listed. Benefit values are determined using a unitless scale of positive and negative values (+10 to −10) for each variable. Positive values correspond to desirable

characteristics, and negative values indicate undesirable characteristics. Zero values indicate either "does not apply" or "indifference" (neither good nor bad). Large negative values usually indicate a serious deficiency in the design of a proposed facility which may cause its rejection or suggest possible modifications to improve it.

Many of the variables are composed of parameters called components, which are sometimes subdivided into characteristics. For example, the variable "climate control and weather protection" (2.2.4) is measured with the use of four component scores: heating, air conditioning, ventilation, and protection. Protection is in turn scored by considering such characteristics as exposure to sunlight, wind, precipitation, and so forth.

Great care was taken in selection and definition of the evaluation variables and in development of specific measurement techniques for each. Critical review meetings were held with a group of SRI specialists to ensure inclusion and logical arrangement of all significant impacts of pedestrian facilities, and to ensure that no items were included more than once (double counted) in the measurement process. Multiple use of components and characteristics (such as lighting) is limited in each appearance to a specific role, such as crime prevention.

Users of this research are encouraged to make changes to specific measurement techniques whenever such changes seem appropriate. When particular groups of evaluators or decision-makers feel that somewhat different values are more appropriate, they should be used. A primary objective to the development of these measurement techniques has been to develop a flexible, quantitative framework for examining and evaluating the many potential impacts of pedestrian facilities. Thus, the basic techniques can be used even if specific values for individual variables or components change over time.

1. TRANSPORTATION

Economic costs have traditionally dominated the planning, evaluation, and selection of transportation projects, not because the intangibles were viewed as unimportant, but rather because the means for measuring them were not generally accepted. Today, there is still no generally accepted procedure for assessing traveler- and travel-related impacts of transportation projects, but there is a definite trend and an established need for the inclusion of these factors in the analysis. A suggested solution to fill this need is provided with the nine variables described in the following. Only one of these variables (1.2.1, motor vehicle travel costs) is an economic cost; the eight remaining factors are more intangible, such as pedestrian comfort and convenience.

1.1 Pedestrians

None of the four variables, travel time, ease of walking, convenience, and special provisions, described for the evaluation of pedestrian transportation are costable in dollars, although they can all be evaluated objectively. Pedestrian travel time (1.1.1) can be expressed in dollars, as is done for motor vehicle travel time, but the objective is to evaluate all variables on a unitless +10 to −10 scale. For the convenience of those performing other types of analyses, for which a dollar assignment to pedestrian travel time might be useful, a discussion of unit pedestrian travel time values has been included in Section 2.

1.1.1 Travel Time

This variable is concerned with the computation of total pedestrian travel time for a particular facility. It may be computed according to

$$\text{Total travel time} = \text{No. of pedestrians} \times \left(\frac{\text{Route length}}{\text{Walking speed}} + \text{Signal delay}\right) \quad \text{(A-1)}$$

The following sections describe procedures for evaluating the components of Eq. A-1.

1.1.1.1 Number of Pedestrians and Route Length. Both of these variables are inherent to the planning and design process for pedestrian facilities, described as Step 4 of the suggested evaluation process (Fig. 2) described in Chapter Two.

Route length may be determined from plans for the facility (such as engineering drawings or blueprints) as part of Step 4. In general, pedestrian routes will be less than 3,000 ft (915 m) in length. To avoid circuitous routing, walking distance should be equal to no more than approximately 1.4 times the straightline distance from origin to destination, and preferably less than 1.2 times (Vuchic and Kikuchi, 1974). If pedestrians have alternate routes to choose from, determine average route length based on the proportion of pedestrians who do (or are expected to) use the various routes.

1.1.1.2 Walking Speed. Average unimpeded pedestrian speed is about 295 ft per min (1.50 m/sec).* This is the value given by Oeding (1963), the upper end of the range given by Lövemark (1972), and is in excellent agreement with Hoel (1968) and Claxton (1974). This is an average value for general applications, when there are no impedances to flow. For commuters in busy downtown areas, 267 ft per min (Fruin, 1971) is a better value, whereas 320 ft per min (Navin and Wheeler, 1969; agrees with Hankin and Wright, 1958) is more appropriate for students. The researchers measured pedestrian travel speeds of 270 to 300 ft per min in downtown Ottawa, Ont., and 244 to 258 ft per min in downtown Brooklyn, N.Y. (slower because of high pedestrian density).

When there is a concentration of pedestrians in an area, naturally, these speeds will be reduced. The speed is reduced by an amount directly proportional to the density of the pedestrians according to Eq. A-2, but this correction only becomes significant at high densities (such as one pedestrian per 10 sq ft):

$$\text{Adjusted speed} = \text{Speed} - B \times \text{Pedestrian density} \quad \text{(A-2)}$$

Values for B, which when divided by the initial speed equals the theoretical maximum space allocation per pedestrian at

* To convert the other travel speeds in this discussion from ft per min to m/sec, multiply by 0.00508.

the point when congestion causes everyone to halt, are as follows (Pushkarev and Zupan, 1975a):

Type of Flow	Initial Speed (ft/min)	B (ft^3/min)
Downtown commuters	267	722
Mixed traffic	295	835
Students	320	1,280

For example, if a downtown mall had a total area of 500,000 sq ft and 1,000 commuters were walking through it,

$$\text{Adjusted speed} = \text{Speed} - B \times \text{Density}$$
$$= 295 \frac{\text{ft}}{\text{min}} - 835 \frac{\text{ft}^3}{\text{min}} \times \frac{1{,}000}{500{,}000\ \text{ft}^2}$$
$$= 293 \frac{\text{ft}}{\text{min}}$$

only a minor correction.

In addition to density, walking speed reductions of up to 25 percent may occur for extreme age or grades. However, no corrections are necessary for ages less than 65 years or for grades of up to 5 pecent (Fruin, 1971). Also, pedestrians walk about 10 percent faster in subfreezing weather than they do in 65- to 75-F (18 C to 24 C) temperatures, according to Hoel (1968), so when examining wintertime use of facilities in cold-weather climates, increase the assumed walking speed by 10 percent.

1.1.1.3 Signal Delay. Pedestrian delay at signalized intersections can be determined from a simple calculation based on signal timing measurements. It is assumed from experience that pedestrians arrive at random times and that they will begin to cross at any time during the green phase. If fraction, F, of the pedestrians wait when they arrive at a red, amber, or flashing DON'T WALK signal, the mean delay is given by

$$D = \frac{F\,(R + A)^2}{2(G + R + A)} \tag{A-3}$$

in which

- D = average delay per pedestrian;
- F = the fraction of pedestrians who obey the signal;
- R = the duration of the red or DON'T WALK signal;
- A = the duration of the amber or flashing DON'T WALK signal; and
- G = the duration of the green or WALK signal.

Of course, for a pedestrian-actuated signal, parameters for pedestrian delay must be established based on the particular characteristics of the traffic control device.

Calculation of the delay most likely to be incurred by pedestrians at crossings without signals or signs has been made by Joyce et al. (1975), based on empirical measurements made in the London Borough of Hammersmith and the Royal Boroughs of Kensington and Chelsea, both in the United Kingdom. The formula that assumes that the pedestrian will cross the street directly in one movement rather than cross halfway and wait, is

$$D = 6.7 \times 10^{-6}\,(Q)^2 + 0.3 \tag{A-4}$$

in which D is the delay most likely to be incurred, in seconds, and Q is the total hourly vehicle flow in both directions. Eq. A-4 is not valid for vehicle flows greater than 1,600 per hour or for mean delays greater than 18 sec, at which points more site-specific relationships must be developed based on vehicle mix and speeds, street width, and pedestrian population.

1.1.1.4 Total Travel Time. Once the route length and walking speed for the types of pedestrians expected to use the pedestrian facility have been determined, distance should be divided by speed to obtain the travel time for each trip across the facility. This time per trip should then be multiplied by the number of pedestrians expected to use the facility to obtain total time. Symbolically, for each grouping of pedestrians:

$$\text{Time per trip} = \text{Route length} \div \text{Walking speed} \tag{A-5}$$

$$\text{Total time} = \text{No. of pedestrian trips} \times \text{Time per trip} \tag{A-6}$$

1.1.1.5 Unit Pedestrian Travel Time Savings. This information may be recorded on the following chart. Weighting the travel times for the four groups shown is recommended, based on each group's mean wage rate. The value of time for people who are walking in the course of their work should be valued at 1.5 times the value for commuters and workers on lunch break because of the money expended by their employers for salary, payroll taxes, and overhead or profit. Similarly, other pedestrians, particularly those on leisure trips, personal business, or persons who are not employed have a time value about one-half of that for commuters, because pedestrian travel time savings cannot be readily converted into employment for them. The value of time for elementary school children is very low (one-tenth of that for commuters, unless their travel decision is made by a parent, in which case it might be higher) because they have very little money but lots of free time.

	BEFORE	AFTER
Number of commuters or workers on lunch break	______	______
Travel time per person	______	______
Total travel time	______	______
Number of people walking in the course of their work	______	______
Travel time per person	______	______
Total travel time	______	______
Multiply by 1.5	______	______
Number of elementary school children	______	______
Travel time per child	______	______
Total travel time	______	______
Multiply by 0.1	______	______
Number of other pedestrians	______	______
Travel time per person	______	______
Total travel time	______	______
Multiply by 0.5	______	______
Total travel time in equivalent minutes	______	______

Weighting commuters' time by 1, the travel time of people walking in the course of their work by 1.5, elementary school children's time by 0.1, and other pedestrian time by 0.5 will result in a total travel time in "equivalent" minutes, equivalent to the specified amount of travel time for commuters or those workers on their lunch break.

A unitless score for travel time is obtained by using Eq. A-7 and the values of total travel time in equivalent minutes determined using the foregoing chart:

$$\text{Total TRAVEL TIME SCORE} = \frac{\begin{pmatrix}\text{Total travel}\\ \text{time before}\end{pmatrix} - \begin{pmatrix}\text{Total travel}\\ \text{time after}\end{pmatrix}}{\text{Maximum of above terms}} \times 10 = \_\_\_\_\_\_ \qquad \text{(A-7)}$$

If this evaluation is being used to compare a number of sites, the maximum value indicated should be the largest term for all sites under consideration.

1.1.2 Ease of Walking

Ease of walking may be described in terms of five components: condition of the walking surface, grade changes, path continuity, signing, and lighting. Techniques for measuring these components are described in the following sections. The range in number of points assigned to each is given in the following, which may also be used to summarize the scores of the different sections:

	Scoring Range	Score
Walking surface	−2 to +2	
Grade changes	−4 to +2	
Continuity	−1 to +2	
Signing	−1 to +2	
Lighting	−2 to +2	
Total EASE OF WALKING SCORE	−10 to +10	

1.1.2.1 Walking Surface. Check off the appropriate boxes in response to the following questions:

	YES	SOMEWHAT	NO
Is the walking surface esthetically appealing? Consider color, texture, and sound.	1/2	0	-1/2
Is the surface comfortable to walk on, even for someone who is wearing high-heel shoes or sandals? A comfortable walking surface is neither too hard nor too soft. Considering comfort only, dry soil is ideal. Concrete is too hard, whereas sand is too soft.	1/2	0	-1/2
Is the pavement free of severe cracks or holes?	1/2	0	-1/2
Is the surface slip-proof, especially when wet or freezing?	1/2	0	-1/2

WALKING SURFACE SCORE is the sum of values in boxes checked = ________.

1.1.2.2 Grade Changes. These scales assume bidirectional flows, hence both upgrades and downgrades. If the facility allows pedestrian flow in only one direction (e.g., a bus unloading area), an upgrade should result in a more negative score and a downgrade should result in a less negative score. Fruin (1971, p. 41) provides data on how slope affects free-flow walking speed, which was used to help determine scores for the steepness of slope. Cantilli (1972) supplies information on requirements for escalators, based on distances of activity areas below surface level.

Steepness of Slope

Grade (%)	Points
5 or less	1
10	0.5
15	−0.5
20	−1.5
25	−2.0

For slopes less than 25 ft (7.6 meters) in length, score 1 point. If a slope greater than 25 percent is planned, serious consideration should be given to redesigning the facility.

STEEPNESS SCORE selected = ______

Vertical Distance to Climb Without Mechanical (Elevator or Escalator) Assistance

Distance (ft)*	Points
0	1
25	0
50	−1
75	−1.5
100 or more	−2

* To convert feet to meters, multiply by 0.3048.

Vertical score selected = ______

COMBINED GRADE SCORE is Steepness score + Vertical score = ______.

1.1.2.3 Continuity. Check off the appropriate boxes in response to the following questions:

	YES	SOMEWHAT	NO
Are there continuous, unbroken, unambiguous pedestrian paths?	1	1/2	0
Are there small jogs or slight bends in the path, but not enough to make the route highly irregular?	1	1/2	0
Is there an absence of obstacles to the flow of pedestrians?	1	1/2	0

CONTINUITY SCORE is the sum of values in boxes checked ______ - 1 = ______.

1.1.2.4 Signing. Check off the appropriate boxes in response to the following questions:

	YES	NO	UNNECESSARY
Are directions to important destinations given or maps of the area provided?	1	0	1
Is there proper signing for safety?	1	0	1
Are any rules or other important information conveyed if necessary?	1	0	1
Are the signs simple and easy to understand?	1	0	1
Can they be understood by persons who cannot read English?	1	0	1
Can they be read by persons with poor eyesight or colorblindness?	1	0	1
Are signs located at likely points of confusion or indecision?	1	0	1
Is there a clear, unobstructed view of each sign?	1	0	1
Are the signs illuminated properly, free of glare?	1	0	1

Signing Point Score is sum of value in boxes checked = ________

Total SIGNING SCORE is Point Score ________ ÷ 3 ________ - 1 = ________

1.1.2.5 Lighting. Lighting effectiveness can be measured in terms of the amount of illumination, the type of lighting, and the height of the lamps.

Level of Illumination.—Now that energy conservation is generally accepted as a desirable public policy, lighting standards may be lowered accordingly, if they continue to satisfy safety and comfort criteria. Thus, existing standards or rules of thumb should not be accepted without question, and reevaluation may be warranted.

The illumination level may be measured with a small hand-held light meter. Also, when making test measurements, it was found that the ambient light in a city (until around midnight in the case of Ottawa) can add 5 ft-c * or more to each reading, so it is best to perform these measurements very late at night (for outdoor facilities), after most of the city has gone to sleep. The measurements should be made about 5 ft (1.5 m) above the ground at representative pedestrian locations. Try to measure an average location, taking into consideration the placement of lights, rather than use an average of the measurements taken. The level of illumination can be translated into a point value according to the following:

* To convert foot-candles to lumen per square meter (lux) multiply by 10.764.

Level of Illum. (ft-c) *	Points
15 or more	0
10 or more	—0.5
5 or more	—1.5
2 or more	—2.0
less than 2	—2.5

* To convert foot-candles to lumen per square meter (lux) multiply by 10.764.

Level score selected = ________

Type of Lighting.—Certain types of lighting (such as incandescent) are soft to the eye, whereas others (such as sodium or strontium vapor) are very harsh. Fluorescent and neon lights fall somewhere between. Scores are assigned to these differing degrees of harshness or softness as follows:

Type of Lighting	Points
Soft: incandescent	0
Medium: neon or fluorescent	—0.5
Harsh: sodium or strontium vapor	—1

Type score selected = ________

Height of Lamps.—Highways are wide and must accommodate tall vehicles, so that lights are located on poles 40 ft (12 m) high. This height is unnecessary and undesirable for pedestrian activity areas, for which 10- or 12-ft (3 m) pole heights are more suitable.

Height of Lamps	Points
Lighting is on a pedestrian scale	0
Lighting is automobile oriented	—0.5

Height score selected = ________

Combined Lighting Score.—COMBINED LIGHTING SCORE is Level score + Type score + Height score = ________, + 2 = ________.

1.1.3 Convenience (Availability and Access)

This variable is measured by considering the availability of the facility to its users and the variety of activities that it makes more accessble to pedestrians (or bicyclists).

1.1.3.1 Time Facility Is Open for Use.

Situation	Points
Open at all times that facility is required	0
Open part-time for special purposes; e.g., lunch hours, school hours, daytime, peak travel hours, weekends	—2
Open part-time only for reasons indirectly related to the facility, such as when major stores are open or when there is (or is not) heavy traffic	—6
Open only rarely, randomly, or irregularly	—10

TIME SCORE selected = ________.

1.1.3.2 Accessibility. Does the facility make pedestrian (or bicycle) travel more convenient to:

Transit	☐
Parking	☐
Transportation terminals	☐
Bike routes	☐
School or education centers	☐
Recreational, historical, or cultural facilities	☐
Medical facilities	☐
Places of worship	☐
Retail stores	☐
Residential areas	☐

ACCESSIBILITY SCORE is number of boxes checked = ________

1.1.3.3 Total Convenience Score.
Total Convenience score is Time score + Accessibility score = ______.

1.1.4 Special Provisions for Various Groups

Special provisions to accommodate special groups of pedestrians (children, elderly, visually or mobility handicapped, bicyclists, joggers, strollers) usually benefit all pedestrians by making it easier for them to walk. Thus, signs that are intelligible to children or visible to partially sighted persons are included under signing (1.1.2.4). Improved signs benefit all pedestrians, just as benches for the elderly can be used by any tired pedestrian, and thus are included in pedestrian-oriented environment (2.2.1). Only those provisions that were not included elsewhere are included here. The following questions are self-explanatory; check off the appropriate items. Spencer (1975) furnishes an excellent set of design criteria for accommodating physically handicapped pedestrians.

	YES	NO	NOT APPLICABLE
Is maximum curb or step height 6 inches* or less?	1	0	1
Are ramped curb cuts provided?	1	0	1
Are all walkways at least 5 feet† wide?	1	0	
Are there any interior areas that are not accessible by at least one nonrevolving door, easy to open, at least 32 inches wide?	0	1	1
Are there any grade changes greater than 15 feet for which ramps or elevators are not provided?	0	1	
Are there any pedestrian-activated crossing signal buttons located more than 40 inches above the ground?	0	1	1
Is there any public telephone with at least 27 inches clearance underneath, but the dial a maximum of 48 inches from the ground?	1	0	
Is there a drinking fountain whose top is no more than 33 inches above the ground?	1	0	
Are changes in pavement texture provided to assist blind pedestrians through difficult crossings?	1	0	1
Are there angular corners, rather than rounded, to allow for better directional orientation?	1	0	1
Are other aids provided for the blind (e.g., sound devices, braille signs, chains, guides)?	1	0	1
Are crossing signals audible?	3	0	3
Are bicycle racks or storage areas for bicycles provided?	3	0	
Is a right-of-way provided for bicycles, separate from that of pedestrians?	3	0	
Is there a dirt, wood chip, or other soft path available for joggers? Jogging on hard surfaces can cause "shin splints" and damaged arches, commonly known as flat feet, according to Hodges (1975).	3	0	
Are there any locations appropriate for placement of handrails, where they are not provided?	0	1	1
Do sewers or gratings hinder access for vehicles with narrow wheels or persons with narrow shoes?	0	1	

Point Score is sum of values in boxes checked = ________

Total SPECIAL PROVISIONS SCORE is Point Score × 0.8 = ________,

- 10 = ________.

*To convert inches to centimeter, multiply by 2.540.
†To convert feet to meters, multiply by 0.305.

1.2 Motor Vehicles

An important economic impact of a pedestrian facility is the increase or decrease in costs of automobile transportation resulting from changes in traffic flow and routes. Just as in Section 1.1, where increase in accumulated pedestrian delay is considered a disbenefit, that portion of vehicle delay, vehicle operating and ownership costs, and changes in the likelihood of accidents caused by the pedestrian facility are considered in the following.

The four sections following provide guidance on the computation of motor vehicle operating costs, travel time for motor vehicle occupants, parking costs, and vehicle ownership, respectively. These may be computed on either a daily or an annual basis (or any other period convenient to the analyst, as long as all calculations are performed for the same period). If daily costs are to be computed, select a typical working day as the standard.

The following description of a procedure for evaluating motor vehicle travel costs is the longest of all variable descriptions. That does not imply that this variable is more important than any of the others; it simply reflects the fact that the computation has more steps and involves more highly developed data than are available for other variables.

1.2.1 Motor Vehicle Travel Costs

1.2.1.1 Motor Vehicle Operating Costs. This section is largely extracted from the final report for NCHRP Project 2-12, "User Benefit Analysis for Highway and Bus Transit Improvements" (Andersen et al., 1975), where more complete information can be found.

Motor vehicle operating costs, as the sum of basic section costs, accident costs, and delay costs, are given by

$$\mathrm{HU} = (B + A) \times L + D \qquad \text{(A-8)}$$

in which HU is the unit highway user cost for a given section of highway, in dollars per 1,000 vehicles. Highway user costs herein are all expressed in dollars per 1,000 vehicles or vehicle-miles. To convert to cents per vehicle or vehicle-mile, multiply by 0.10, inasmuch as $\$1/1{,}000$ veh $= 0.1¢$/veh. To convert to cost per kilometer, multiply by 0.621. B represents basic section costs, consisting of the unit cost (time value and vehicle running costs) associated with vehicle flow and the basic geometrics (grades and curves) of the analysis section; A represents unit accident costs in the analysis section; L represents analysis section length, in miles (preferably to the nearest hundredth); D represents additional unit time and running costs caused by delays at intersections, traffic signals, stop signs, or other traffic control devices.

The nomographs in Figures A-1 through A-3 enable direct calculation of B, basic section costs, for three types of highways as a function of either the ratio of traffic volume over highway capacity ratio or the average running speed. Examples illustrating the use of these nomographs are provided on the figures themselves. The nomographs are entered at the lower left, either with volume/capacity ratios (estimated by the analyst for the representative hour of operation of the analysis section) or with average running speed. The analysis proceeds to determination of travel time (the inverse of running speed) portrayed on the left-hand scale of the lower left-hand graph; tangent running costs, and added running costs due to curves. Added running costs due to speed change cycles are then derived by entering the upper left-hand graph with the v/c ratio from the lower left-hand graph. The indicated costs of speed changes are minor except for level of service F (queuing) conditions.

Data on vehicle flows should be available to the analyst from traffic records and projections. In calculating the v/c ratio, the capacity of the section under study is the relevant denominator. Because of different roadway widths, traffic mixes, and other conditions, different sections of the same facility may have significantly different capacities. The *Highway Capacity Manual* (1965) should be consulted in estimating section capacities.

If the volume and capacity of a road section are known, average running speed can be estimated directly for different highway design speeds from the lower left-hand chart of Figures A-1 through A-3.

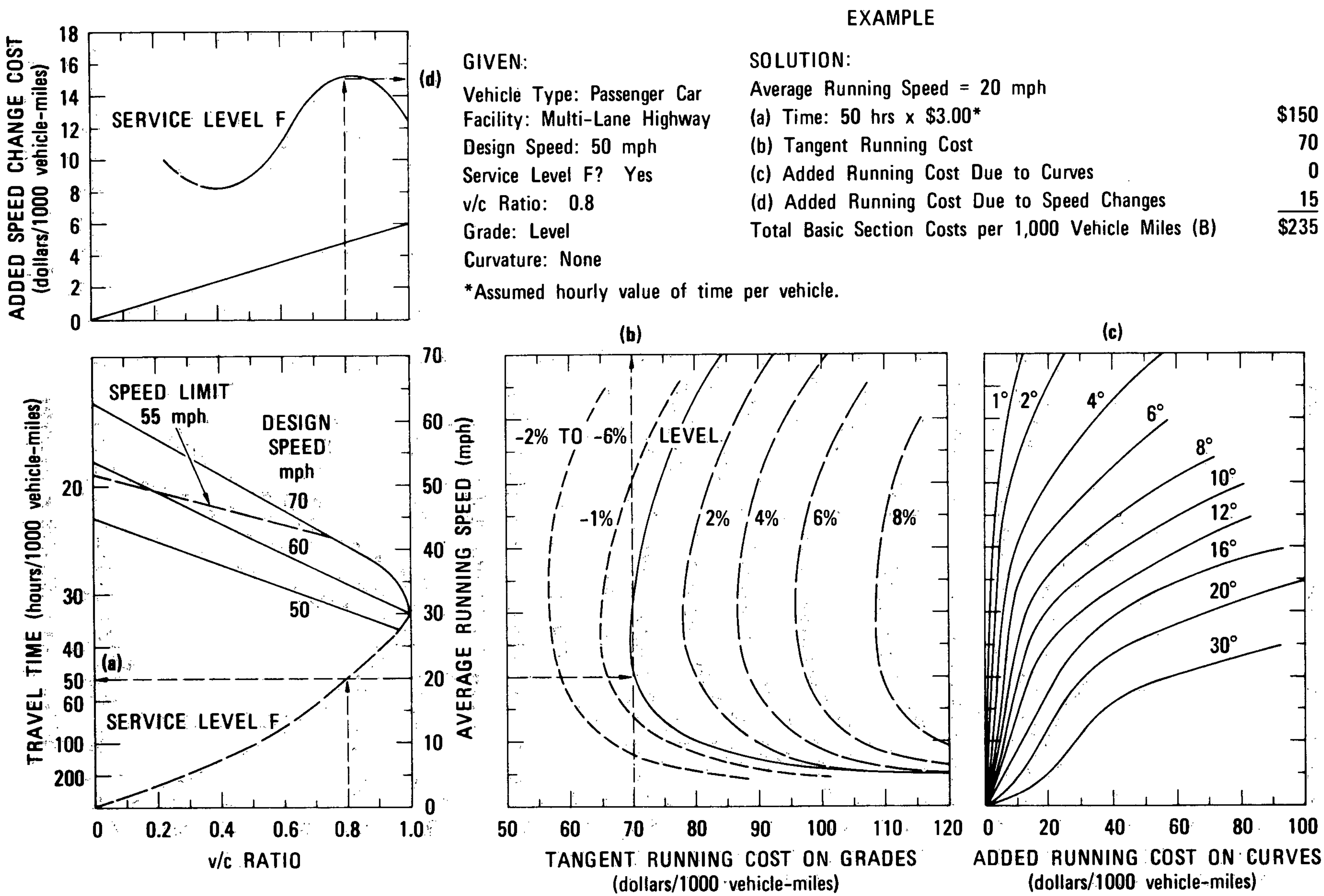
Where more locally valid speed-flow relationships are available, the analyst is urged to use them in place of the lower left-hand chart in Figures A-1 through A-3 to determine average speed. Alternatively, the practice of sending out an observation car to drift with the traffic stream—trying to pass an equal number of cars to those that pass the test vehicle, for example—is useful for obtaining average running speeds of existing highways. However, traffic speed in future years must be derived from the traffic volumes that are forecast for those years, which may have no current counterpart.

Intersection Delay Costs D.—Intersection delay is caused by slowing down and speeding up from a stop caused at an intersection, pedestrian crosswalk, or by a traffic signal, and from idling while stopped. Such costs, symbolized by D, are calculated on a per 1,000-vehicle basis, and should be added to previous estimates of basic section costs.

Intersection delay costs depend primarily on the type and configuration of the traffic control devices employed, the level of traffic on the section, and the speed at which the stop or signal is approached. Figures A-4 and A-5 facilitate calculation of stopping and idling costs as functions of these factors. Examples provided on the figures illustrate their use. Approximate adjustment factors are also provided to account for trucks in the traffic stream.

Figures A-4 and A-5 require data on the following parameters of the signalization and traffic of the intersection under study:

- Green-to-cycle time ratio, λ. The ratio of effective green time of the signal to the cycle length of the signal, both expressed in the same unit of time (usually seconds). In terms of the *Highway Capacity Manual* (HCM), effective green time is the actual green time of the signal. If the HCM is not used, effective green time is defined as the total available for vehicular movement. (If it is assumed that the part of the yellow interval used for vehicular movement and the time lost while the queue gets in motion are equal, both methods of defining effective green time are equivalent.) The cycle length of a signal is the total time taken for



EXAMPLE

GIVEN:

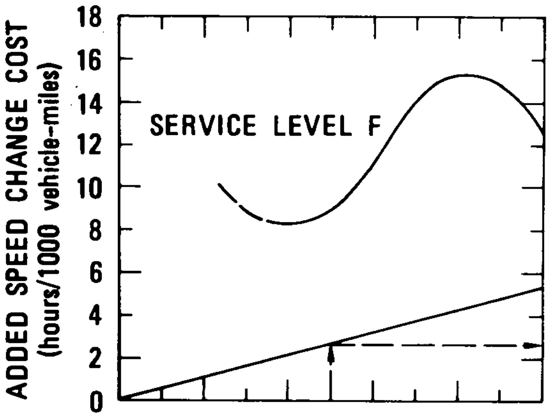
Vehicle Type: Passenger Car
Facility: Multi-Lane Highway
Design Speed: 50 mph
Service Level F? Yes
v/c Ratio: 0.8
Grade: Level
Curvature: None

*Assumed hourly value of time per vehicle.

SOLUTION:

Average Running Speed = 20 mph	
(a) Time: 50 hrs x $3.00*	$150
(b) Tangent Running Cost	70
(c) Added Running Cost Due to Curves	0
(d) Added Running Cost Due to Speed Changes	15
Total Basic Section Costs per 1,000 Vehicle Miles (B)	$235

Figure A-1. Basic section costs, B, for passenger cars of multilane highways.



EXAMPLE

GIVEN:

Vehicle Type: Passenger Car
Facility: Two-Lane Highway
Design Speed: 40 mph
Service Level F? No
v/c Ratio: 0.5
Grade: -1%
Curvature: 16°

*Assumed hourly value of time per vehicle.

SOLUTION:

Average Running Speed = 35 mph

(a) Time: 28.6 hrs x $3.00*	$85.80
(b) Tangent Running Cost	65
(c) Added Running Cost Due to Curves	60
(d) Added Running Cost Due to Speed Changes:	2.60
Total Basic Section Costs per 1,000 Vehicle Miles (B)	$213.40

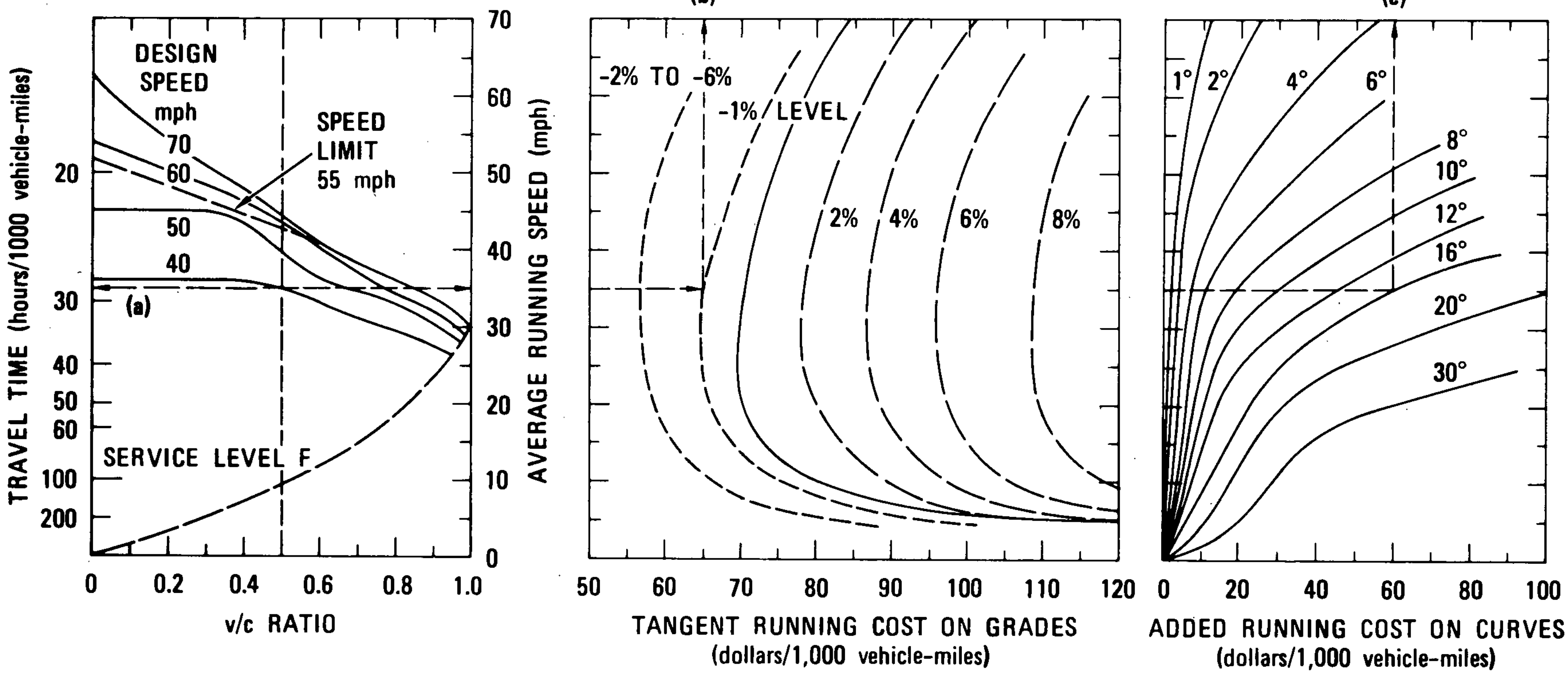
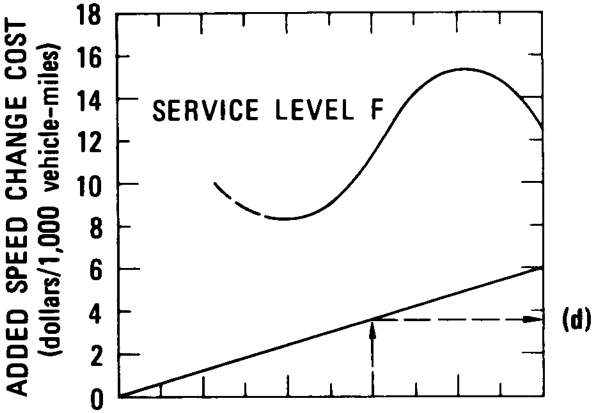


Figure A-2. Basic section costs, B, for passenger cars on 2-lane highways.



EXAMPLE

GIVEN:

Vehicle Type: Passenger Car
Facility: Arterial
Speed Limit: 45 mph
Service Level F? No
v/c Ratio: 0.6
Grade: -4%
Curvature: None

*Assumed hourly of time per vehicle.

SOLUTION:

Average Running Speed = 40 mph

(a) Time: 25 hrs x $3.00*	$75
(b) Tangent Running Cost	57
(c) Added Running Cost Due to Curves	0
(d) Added Running Cost Due to Speed Changes	3.60
Total Basic Section Costs per 1,000 Vehicle Miles (B)	$135.60

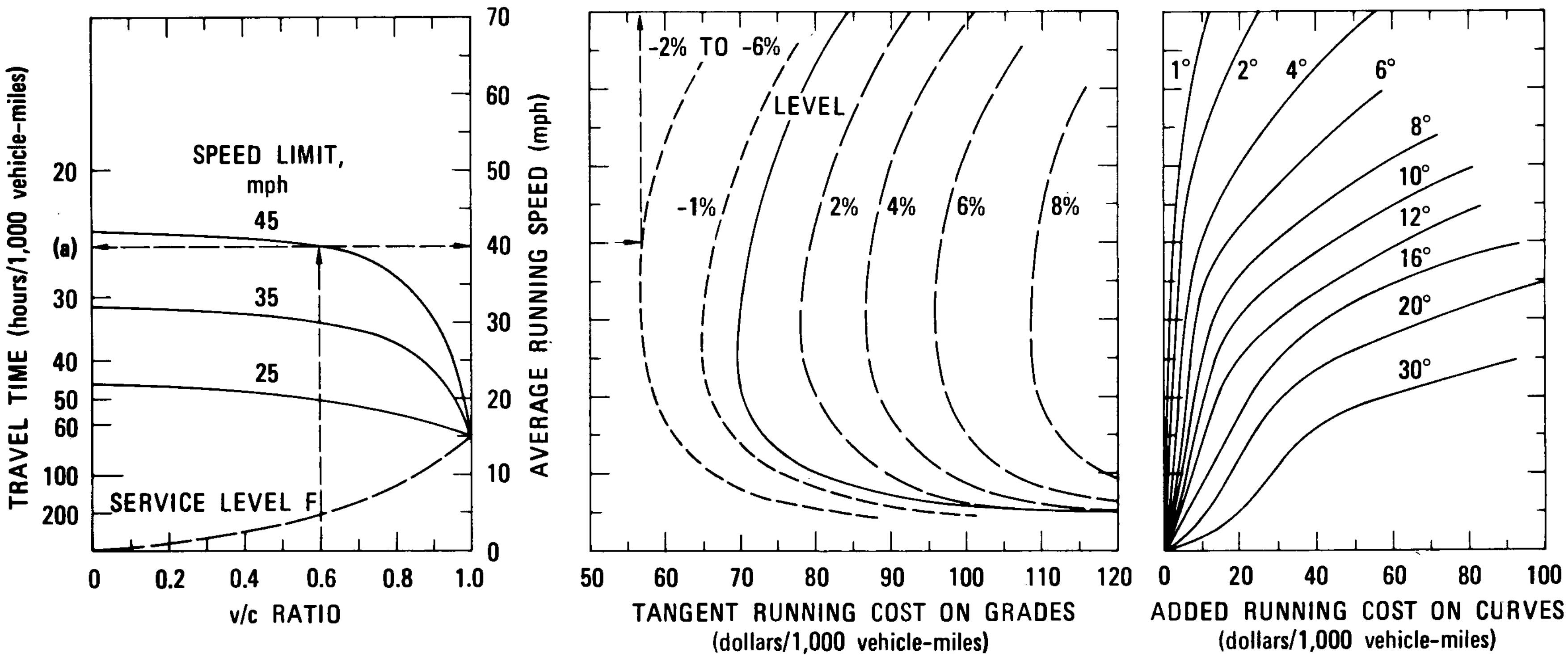


Figure A-3. Basic section costs, B, *for passenger cars on arterials.*

EXAMPLE

GIVEN:

Volume: 480 vehicles/hr
Saturation Flow: 1,600 vehicles/hr
Signal Cycle Time: 60 sec
Effective Green Time: 30 sec
Intersection Approach Speed: 30 mph
5% Single Unit Trucks
5% 3-S2 Combination Trucks

SOLUTION:

$\lambda = 30/60 = 0.5$
Capacity of Approach = 0.5 x 1600 = 800
$X = 480/800 = 0.6$
(a) Average Stops per Vehicle (per Signal): 0.71
(b) Stopping Delay per Signal: 2.5 hrs
(c) Cost of Stopping: $10.30

Time Cost: 2.5 x $3.00* x 1.35†	$10.13
Running Cost: $10.30 x 1.42†	14.63
Total Cost Due to Stopping per 1,000 vehicles per Signal (excludes idling):	$24.76

*Assumed hourly value of time per passenger car.
†Adjustment factors for trucks in traffic stream.

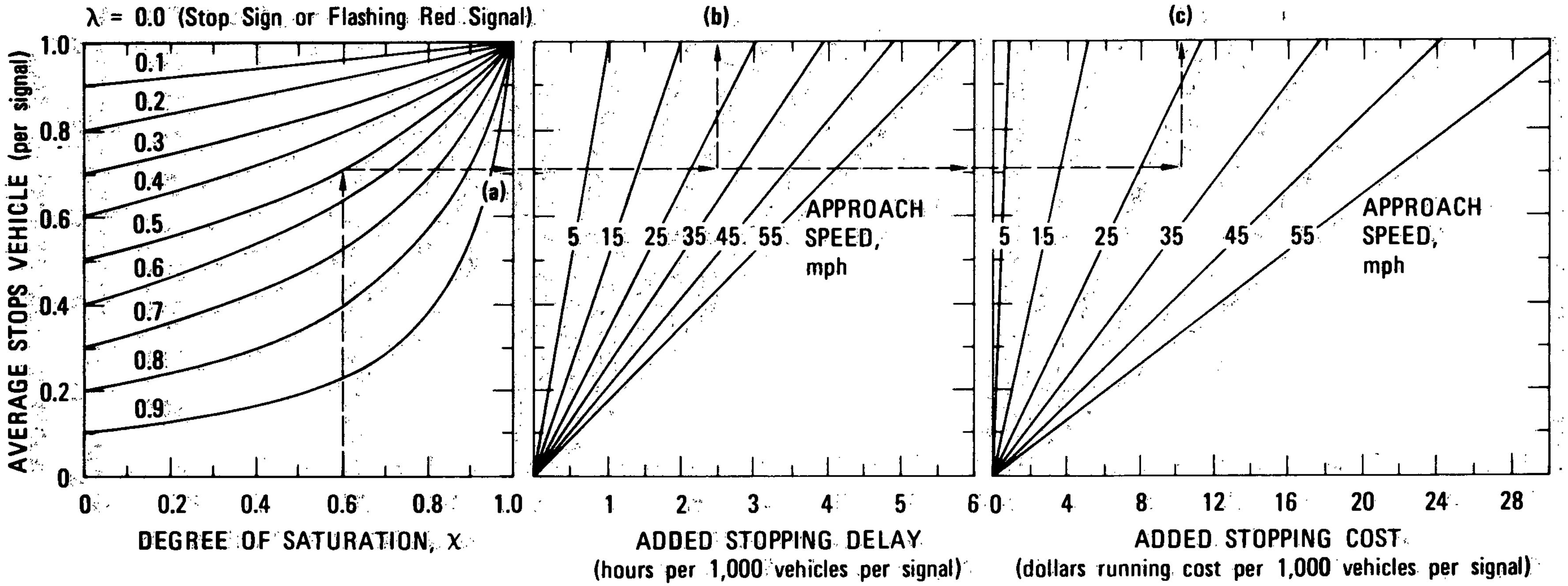
ADJUSTMENT FACTORS FOR PERCENT TRUCKS IN TRAFFIC STREAM

TIME COST

APPROACH SPEED (mph)	SINGLE UNIT TRUCKS (percent)	3 S-2 COMBINATION DIESEL TRUCKS (percent in traffic stream)				
		0	5	10	20	100
5-20	0	1.00	1.15	1.30	1.61	4.03
	5	1.07	1.22	1.37	1.67	–
	10	1.13	1.28	1.43	1.74	–
	20	1.26	1.41	1.57	1.87	–
	100	2.31	–	–	–	–
21-40	0	1.00	1.25	1.51	2.01	6.05
	5	1.10	$\boxed{1.35}$	1.60	2.11	–
	10	1.20	1.45	1.70	2.21	–
	20	1.40	1.65	1.90	2.41	–
	100	2.99	–	–	–	–
41-60	0	1.00	1.41	1.82	2.63	9.17
	5	1.11	1.56	1.93	2.74	–
	10	1.22	1.61	2.04	2.85	–
	20	1.44	1.85	2.26	3.07	–
	100	3.20	–	–	–	–

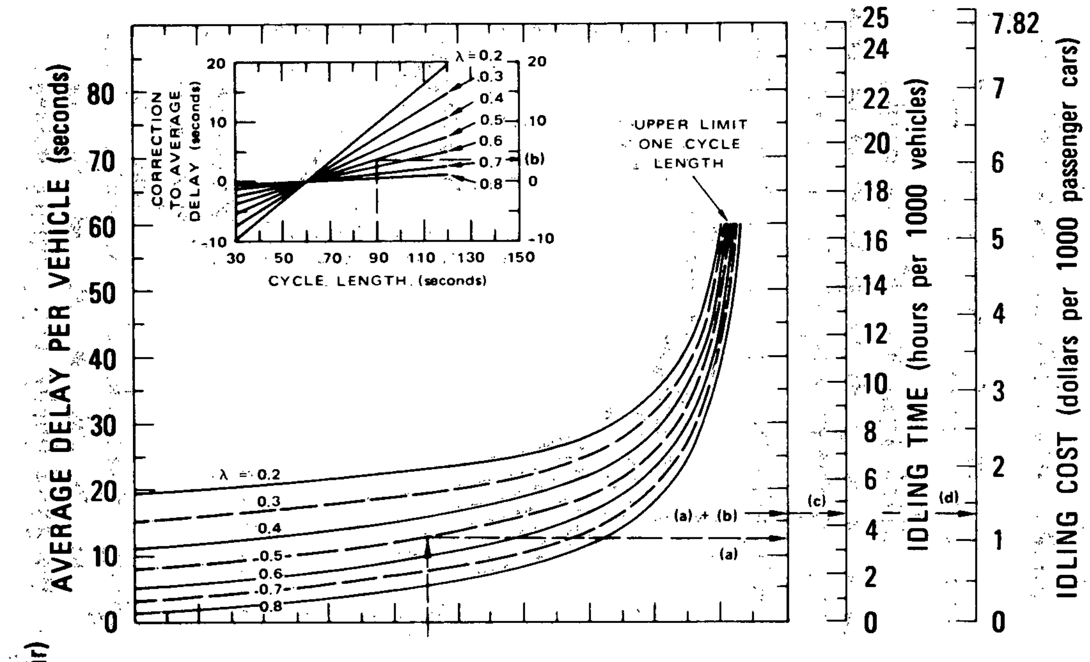
RUNNING COST

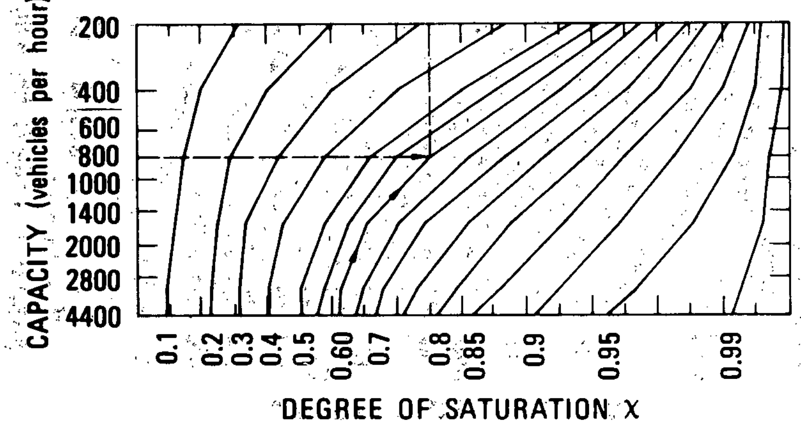
APPROACH SPEED (mph)	SINGLE UNIT TRUCKS (percent)	3 S-2 COMBINATION DIESEL TRUCKS (percent in traffic stream)				
		0	5	10	20	100
5-20	0	1.00	1.35	1.70	2.40	8.02
	5	1.08	1.43	1.78	2.49	–
	10	1.16	1.51	1.86	2.57	–
	20	1.32	1.68	2.03	2.73	–
	100	2.62	–	–	–	–
21-40	0	1.00	1.35	1.71	2.41	8.07
	5	1.07	$\boxed{1.42}$	1.78	2.48	–
	10	1.14	1.49	1.84	2.55	–
	20	1.27	1.63	1.98	2.69	–
	100	2.37	–	–	–	–
41-60	0	1.00	1.35	1.70	2.39	7.96
	5	1.06	1.41	1.76	2.45	–
	10	1.12	1.47	1.82	2.51	–
	20	1.24	1.59	1.94	2.63	–
	100	2.21	–	–	–	–



NOTE: Where $X = v/\lambda s = v/\text{capacity}$ s = saturation flow   v = volume   λ = green to cycle time ratio

Figure A-4. Costs caused by stopping at intersection (excludes idling).





ADJUSTMENT FACTORS FOR PERCENT TRUCKS IN TRAFFIC STREAM

IDLING TIME FACTOR		3-S2 COMBINATION TRUCKS (percent) 0	5	10	20	100
SINGLE UNIT TRUCKS (percent)	0	1.00	1.08	1.17	1.33	2.67
	5	1.07	$\boxed{1.15}$	1.23	1.40	–
	10	1.13	1.22	1.30	1.47	–
	20	1.27	1.35	1.43	1.60	–
	100	2.33	–	–	–	–

IDLING COST FACTOR		3-S2 COMBINATION TRUCKS (percent) 0	5	10	20	100
SINGLE UNIT TRUCKS (percent)	0	1.00	0.98	0.96	0.92	0.62
	5	0.99	$\boxed{0.98}$	0.96	0.92	–
	10	0.99	0.97	0.95	0.91	–
	20	0.98	0.96	0.94	0.90	–
	100	0.89	–	–	–	–

EXAMPLE

GIVEN:

X = 0.6

Capacity = 800

λ = 0.5

Cycle Length: 90 seconds

5% Single Unit Trucks

5% 3-S2 Combination Trucks

SOLUTION: Average Delay per Vehicle: (a) + (b) = 16.2 sec

(c) Idling Hours: 4.5 hrs

(d) Idling Cost: $1.40

Total Delay: 4.5 hrs x $3.00* x 1.15†	$15.53
Total Idling Cost: $1.40 x 0.98†	1.38
Total Cost Due to Idling per 1000 Vehicles (per signal)	$16.91

*Assumed hourly value of time per passenger car.

†Adjustment factors for percent trucks in traffic stream.

NOTE: Where: X = v/λs = v/capacity s = saturation flow v = demand volume λ = green to cycle time ratio

Figure A-5. Costs caused by idling at intersection.

display of all of the several indications provided by the signal.

For a pedestrian-activated signal, λ is modified as reported by Ferlis and Kagan (1974) according to

$$\lambda_p = \frac{t_b + (1/\lambda)\exp(-\lambda t_b + \lambda t_a)}{P + t_b + (1/\lambda)\exp(-\lambda t_b + \lambda t_a)} \quad \text{(A-9)}$$

in which

λ_p = effective green-to-cycle time ratio for a pedestrian-actuated signal;
t_b = minimum vehicular green time, in sec;
t_a = minimum lag between actuation and signal response, in sec;
P = pedestrian volume, in pedestrians per sec.

- Saturation flow, s. In terms of the HCM, saturation flow is the approach volume in vehicles per hour of green time that is found for the intersection when the load factor is 1.0 and the appropriate adjustment factors are applied. In the absence of HCM solutions, recommended values for saturation flow are 1,700 to 1,800 veh/hr times the number of approach lanes.
- Capacity, c. Where the HCM is used, capacity is the service volume of the approach at a load factor of 1.0. It is also equal to the saturation flow times the green-to-cycle time ratio.
- Degree of saturation, X. The ratio of the volume of traffic approaching the intersection (usually in veh/hr) to the capacity of the intersection (usually in veh/hr).
- Approach speed. Also termed "midblock speed," this is the average running speed at which the signalized intersection is approached by the vehicle running stream.

For an unsignalized (zebra) crossing, where the pedestrian has the right-of-way over passing vehicles and the drivers are expected to wait until all pedestrians have crossed the road, the average delay to vehicles can be computed from Eq. A-10, as reported by Pillai (1975), based on a regression analysis of field data and simulation:

$$d = c\,K\,T^2/60 \quad \text{(A-10)}$$

in which

d = average delay to vehicles due to pedestrians stopping them;
c = varies between 0.7 and 1.0 for $K \leq 4$; 0.85 is good to use for a first cut;
K = the number of times vehicles are stopped by pedestrians in 1 min
$= 0.18\sqrt{P\,V} - 0.58$;
P = flow of pedestrians per minute in both directions;
V = flow of vehicles per minute in both directions;
T = the duration of crossing for a group of pedestrians
$= t + 0.78\left(\frac{P + 4.54}{4}\right) - 0.58$; and
t = average pedestrian crossing time, in sec;

To determine the maximum pedestrian and vehicle flow that can exist without any delay to vehicles, set K (the number of tiems vehicles are stopped by pedestrians in one minute) = 0. This would require:

$$P\,V \leq 10.38 \quad \text{(A-11)}$$

In other words, if the product of the vehicle and pedestrian flows is less than 10.38 (e.g., an average of 10.38 veh/min and 1 pedestrian per minute), there will not be any delay to vehicles.

1.2.1.2 Travel Time for Motor Vehicle Occupants. Unlike pedestrians, the majority of automobile drivers and other motor vehicle occupants do not perceive small time savings (or losses) of less than 5 min. Because motorists tend to be making longer trips than pedestrians, there is more variation in the travel time of a specific trip (because of traffic congestion and delays caused by signals). Motorists are also in a relatively comfortable environment, protected from the elements. Hence, time savings for motorists will be valued at a rate that depends on the amount of time saved. The following values for motor vehicle travel time are from the final report of NCHRP Project 2-12 (Andersen et al., 1975):

	Value of Time per Traveler ($)		% of Avg. Family Income
	(hr)	(min)	
For low time savings (0-5 min):			
Average trips	0.21	0.0035	2.8
Work trips	0.48	0.008	6.4
For medium time savings (5-15 min):			
Average trips	1.80	0.03	24.2
Work trips	2.40	0.04	32.2

The percent of average hourly family income figures assume 2,080 working hours a year for the $15,500 average family income of the $14,000 to $17,000 range, or $7.45 per hour, almost 50 percent higher than the assumed average pedestrian wage rate of $5.00 per hour, reflecting the cost of automobile ownership and use. These percentages can be used to adjust time value factors proportionately when average family incomes are outside the $14,000 to $17,000 range.

The per-person time values given can be converted to average values per vehicle through multiplying by the vehicle occupancy factor. Representative factors are as follows, but such values may vary considerably from place to place and over time:

Trip Type	Adults per Vehicle
Work	1.22
Social-recreational	1.98
Personal business	1.64
Average	1.56

The product of travel time value per vehicle occupant and the occupancy of adults per vehicle gives the value of travel time per vehicle-hour. The travel time for highway sections is determined from Figures A-1, A-2, or A-3, depending on the type of road. To this is added deceleration time for stopping at intersections ("stopping delay" in Fig. A-4) and idling time from Figure A-5. Total travel time is then multiplied by the value of travel time per vehicle-hour to give the total value of time saved or delayed for motor vehicle occupants.

1.2.1.3 Parking Costs. Changes in the availability, demand, and hence the cost of parking, should be evaluated. This should be done through use of a field inventory if the data do not already exist in the files of the local transportation or land-use planning agency. Figure A-6 provides a suitable format for the data to be collected.

1.2.1.4 Vehicle Ownership. Savings in automobile ownership can be realized only if a pedestrian/bicycle facility shortens the travel distance significantly (e.g., a freeway crossing where none existed before), greatly improves the walking environment, facilitates the use of transit, or restricts the use of automobiles. This will tend to occur only in multiple-car families when one of the vehicles is used only for a routine trip, such as commuting to work. If any dollar savings in automobile ownership are anticipated, these should be computed and combined with vehicle operating costs (see Sec. 1.2.1.5).

Ownership costs include not only the original cost of the vehicle, as depreciated over its lifetime, but also insurance, registration, garaging, finance charges on automobile loans, and interest foregone by having capital invested in the vehicle rather than in savings. As a rough approximation, assume that these ownership costs average about $1,000 per year for each automobile. This is equivalent to $4 per average working day if there are 250 work days per year. Multiply the estimated change (if any) in number of motor vehicles owned by the cost per vehicle for the analysis period to obtain total ownership savings.

1.2.1.5 Total Motor Vehicle Travel Cost. At this point, combine the motor vehicle cost components computed in the preceding four sections. Assemble these data on the worksheet of Figure A-7. Scoring for this variable is based on the totals of Figure A-7 and is computed according to

$$\begin{array}{c}\text{Total VEHICLE}\\ \text{TRAVEL COST SCORE}\end{array} = \frac{\text{Present cost} - \text{Cost for alt. } i}{\text{Max. of above costs}} \times 10 \qquad \text{(A-12)}$$

If this evaluation is being used to compare a number of sites, the denominator of Eq. A-12 should be the maximum cost for all alternatives under consideration, including the status quo.

1.2.2 Use of Automobiles

In contrast to section 1.2.1, which takes into account the operation costs and travel time for motor vehicle trips, this variable simply considers the number of trips made by automobile, or the mode split between automobiles and pedestrians and transit. Estimates of the number of trips taken by automobile should be made at the same time that pedestrian and traffic volumes are forecast.

The score for this variable is computed according to

$$\text{Score} = 40 \times \left(\frac{M_a}{M_b} - 1\right) \qquad \text{(A-13)}$$

The mode split after initial operation of a pedestrian fa-

Type of Parking Facility	Number of Spaces In Study Area	Hourly Charge Per Space	Average Stay	Turnover Per Day	Daily Revenues Per Space	Total Daily Revenue	Total Annual Revenue
On Street							
Off-Street, Lots							
Off-Street, Enclosed							

Total Number of Spaces ______

Total Cost ______

Figure A-6. Parking cost calculation work sheet.

Cost Component	Existing Situation	Alternative A	Alternative B
1. Motor Vehicle Operating Costs 2. Travel Time for Motor Vehicle Occupants 3. Parking Costs 4. Vehicle Ownership			
Total Motor Vehicle Travel Cost			

Figure A-7. Motor vehicle travel cost summation.

cility, M_a, is equal to the number of trips taken by foot, bicycle, or transit during a specified period (day, month, or year) divided by the total number of trips, including those made by automobile. Similarly, M_b is the mode split of the existing situation; i.e., before there is a facility. If Eq. A-13 produces a score greater than +10 or smaller than −10, use +10 or −10 as the rating. The formula is based on a change in mode split of 25 percent from the status quo accounting for a maximum score; smaller changes are scaled proportionately. Peak-period, off-peak weekday, evening, and weekend trips are all weighted equally, although the evaluator may choose to ocnsider peak-period trips only for this analysis.

Total USE OF AUTOMOBILES SCORE = _______.

1.2.3 Signal/Signing Needs Adjacent to Facility

The cost of signals and signs at and within the facility itself will be included for the total cost for the entire project. However, there might be a need for signs or signals adjacent to the facility:

- For detours or rerouting when a street is closed to motor vehicles.
- To direct pedestrians and bicyclists to the facility.
- To indicate changes in the location of bus stops or routes.

Assign a value between −10 and +10 to the signing requirements, based on these sample guidelines:

−10 Dangerous situation; significant confusion at 3 or more locations.
−5 Clear need for additional major signing.
0 Additional signs useful, but not essential.
+5 Need indicated only for small, routine signs, such as bus stops or route designators.
+7 Minor problem only at one or two locations.
+10 No problem; no need for additional signs.

SIGNAL/SIGNING NEEDS SCORE selected = _____.

1.3 Other Community Transportation

It is important to remember that pedestrian facilities are only one part of the city's and, possibly, the region's transportation system. These two variables consider the impact of the pedestrian facility on the larger transportation and urban environment in which it is situated.

1.3.1 Adaptability to Future Transportation Development Plans

As a part of the over-all planning process, expected future transit and highway developments should be considered to determine if they are likely to have a measurable effect on the facility. For example, plans for a pedestrian crossing over a highway would certainly be changed if at a future date the highway were to be abandoned, relocated, or widened. Similarly, the design for a pedestrian tunnel would be different if plans existed for an underground rapid transit route crossing it.

This factor is intended to provide a judgmental rating for the adaptability of the proposed pedestrian facility to the present and planned transportation system. Based on all the information that is known concerning private and public growth plans for the future of the area, evaluate the adaptability of the pedestrian facility to future transportation and urban development plans on a scale from +10 to −10, as follows:

-10	-5	0	+5	+10
Requires significant modification to city or regional transportation plans to accommodate the facility		No significant effect on current or planned citywide or regional transportation system		Enhances planned future transportation system

FUTURE TRANSPORTATION PLANS SCORE selected = ________.

1.3.2 Impact on Use of Existing Transportation Systems

Pedestrian and vehicle separation facilities may well have impacts on other transportation systems in the community. For example, vehicle or pedestrian rerouting might inconvenience bicyclists who had been accustomed to riding on uncongested routes. Transit lines might have to be rerouted, and buses might become overloaded in the vicinity of the pedestrian facility. Pupils' use of school buses might decline if the children can now cross a freeway safely or walk a shorter distance.

Figure A-8 is intended to be used as a worksheet to specify the extent and magnitude of the impacts. Place a check in each box that corresponds to an expected impact on the indicated mode. If the impact is major, use two checks. Add up the total number of checks on the bottom line.

2. SAFETY/ENVIRONMENT/HEALTH

2.1 Safety

2.1.1 Societal Cost of Accidents

The total societal cost of motor vehicle accidents involving pedestrians is a function of the number of accidents, their severity, and many direct and indirect costs such as medical and hospital, legal, income loss, pain and suffering, and insurance administration costs. This section provides a technique for estimating the relative risk of accident occurrence based on past experience of pedestrian, vehicle, environmental, and traffic control components. By multiplying the accident risk by the number of pedestrian exposures (in terms of pedestrian crossings of vehicle roadways), an estimate can be made of the number of accidents.

Dollar value estimates for total societal costs can be developed using the data from this section and the techniques and cost data given in Chapter Two. The rest of this section describes how relative accident risk is estimated and then used to determine a unitless accident score for alternative pedestrian facilities.

The accident risk per crossing for each facility (or each crossing point affected by the facility if necessary) is estimated using the accident involvement rate adjustment (Fig. A-9). For each crossing to be analyzed (one representative crossing may be evaluated if several similar crossings are involved), check off the boxes that apply, then sum

Transportation Systems	Change in Type of Use	Increase in Use	Noticeable Decline in Use	Modifications Required	Others
Bikeways					
Transit					
School buses					
Terminals					
Bus					
Railroad					
Airport					
Ferry					
Total					

Based upon the entries above, indicate on the scale below the degree of impact of the pedestrian facility on other community transport systems.

-10	-5	0	5	10
Very negative		Neutral impact		Very good

EXISTING TRANSPORTATION SCORE selected = ____.

Figure A-8. Impacts on other transportation systems.

	Number of:	Rate Decreases				Average		Rate Increases			
PEDESTRIAN	Elderly (⩾65)	Few	10	5%	5	10%	0	20%	20	⩾30%	40
PEDESTRIAN	Very Young (⩽10)	Few	10	1%	5	2%	0	4%	20	⩾8%	40
PEDESTRIAN	Alcohol Involved	None	10	Few	5	Mod	0	Mod-High	20	High	40
PEDESTRIAN	Illegal Crossings	None	5	Few	3	Mod	0	Mod-High	10	High	20
VEHICLE	Average Vehicle Volume	Low	5	Mod-Low	3	Mod	0	Mod-High	5	High	20
VEHICLE	Average Vehicle Speed (mph) (kph)	<15 (<25)	5	15-24 (25-39)	3	25-30 (40-49)	0	31-40 (50-65)	10	>40 (>65)	20
VEHICLE	Turning Conflicts	None	5	Few	3	Mod	0	Freq.	5	Many	10
VEHICLE	One-way Traffic		–	Yes	3		–	No	5		–
ENVIRONMENT	Sight Distance	Good	4	Fairly Good	2	Fair	0	Poor	5	Bad	10
ENVIRONMENT	Crossings After Dark (Good Light)	Few	4	Mod-	2	Mod	0		–		
ENVIRONMENT	Crossings After Dark (Poor Light)		–		–	Few	0	Mod	10	Many	20
ENVIRONMENT	Weather	Mild	4	Mod-Mild	2	Mod	0	Mod-Severe	3	Severe	5
CONTROL	Signalization (Presence)			Ped & Veh	10	Veh Only	0	None	20		
CONTROL	Police Enforcement (Ped Laws)			Heavy	3	Mod	0	Light	3		
CONTROL	Active Public Education			Yes	2		–	No	2		

Sum the colums as indicated and divide each sum by 100: Decreases ____/100 = ____ Increases ____/100 = ____

Net Involvement Rate is Increase Rate - Decrease Rate ______ + 1 = ______

Figure A-9. Accident involvement rate adjustment.

the results for both present and planned conditions using the formula below the table to obtain net involvement rates (NI rate) for both situations.

Scoring Pedestrian Accident Costs.—Unitless scoring for pedestrian accident costs is accomplished by computing a comparative crossing risk for each situation by multiplying the annual number of crossings by the NI rate (limited to a maximum of 2.0) for that situation and comparing by use of

$$\begin{array}{c}\text{Total}\\ \text{COST OF}\\ \text{ACCIDENT}\\ \text{SCORE}\end{array} = \frac{\left(\begin{array}{c}\text{Present}\\ \text{no. of}\\ \text{crossings}\end{array} \times \begin{array}{c}\text{Present}\\ \text{NI rate}\end{array}\right) - \left(\begin{array}{c}\text{Proposed}\\ \text{no. of}\\ \text{crossings}\end{array} \times \begin{array}{c}\text{Proposed}\\ \text{NI rate}\end{array}\right)}{\begin{array}{c}\text{Max. of above products}\\ \text{for all facilities being compared}\end{array}} \times 10 = \underline{\qquad}. \qquad \text{(A-14)}$$

If this evaluation is being used to compare a number of sites, the maximum value indicated should be the maximum comparative crossing risk of all sites under consideration.

In Eq. A-14, the numerator represents the difference between the number of accidents before the proposed facility (present), and after the proposed facility. The number of accidents for each case is obtained by multiplying the number of crossings by the NI rate, computed using Figure A-7. The denominator is obtained by selecting the maximum number of accidents (either present or proposed), and dividing the difference in accidents for each individual site by this one number; the individual scores will be proportional to the number of accidents for each facility. For example, if Site A had a reduction of 10 accidents and Site B had a reduction of 5 accidents, the scoring for Site B would be only one-half of the score for Site A. If the denominator were 20, the score for A would be +5 and the score for B would be +2.5 (or rounded to +3). This formulation is used to maintain a level of comparability for the scores of several facilities.

If only the present situation is being compared for a number of sites, Eq. A-15 below should be used for each site. This will provide a relative accident risk index (from 0 to —22.5 for comparing potential pedestrian improvement sites).

$$\begin{array}{c}\text{Relative}\\ \text{accident}\\ \text{risk index}\end{array} = \frac{\begin{array}{c}\text{Present}\\ \text{no. of}\\ \text{crossings}\end{array} \times \left(\begin{array}{c}\text{Present}\\ \text{NI rate}\end{array} - 0.2\right)}{\begin{array}{c}\text{Max. no. of crossings at}\\ \text{any site}\end{array}} \times (-10) = \underline{\qquad}. \qquad \text{(A-15)}$$

Example of Use of Eq. A-14.—Assume a four-block area of a street in a retail area closed lengthwise but with cross streets left open to motor vehicles. The street crossing locations are all similar; their before (present) and after (proposed) net accident involvement rates are 1.45 and 0.85, respectively. The present and estimated future number of person crossings are 12,500 per day and 14,500 per day, respectively.

$$\begin{array}{c}\text{Total}\\ \text{COST OF}\\ \text{ACCIDENTS}\\ \text{SCORE}\end{array} = \frac{(12{,}500 \times 1.45) - (14{,}500 \times 0.85)}{\text{Max. of above products}} \times 10$$

$$= \frac{18{,}125 - 12{,}325}{18{,}125} \times 10 = +3.2 \text{ (or } +3\text{)}.$$

2.1.2 Accident Threat Concern

This variable estimates the degree of anxiety caused by the perceived nature of conflicts between pedestrians and vehicles at conflict locations within the proposed facility or site. For all facilities where some degree of pedestrian/vehicle conflict exists, Figure A-10 is used. Appropriate values are checked, and sums computed as indicated. If separation between pedestrians and vehicles is complete, the score is +10.

2.1.3 Crime Concern

The variable components to be considered here are those that affect the perception of crime by both pedestrians and nearby residents and business persons. It is extremely difficult to predict the number and types of actual crime incidences that will be induced or averted by any particular facility. Wide variations in the physical settings of different facilities, the necessity to incorporate previous crime patterns near the facility location, and lack of specific research in this area all contribute to these difficulties. Facilities that encourage large increases in the number of users may experience crime increases, particularly so-called "petty" crimes (such as vandalism and pickpocketing). However, reasonable enforcement levels can maintain or attain low crime rates in the area of pedestrian facilities if proper consideration of this variable is taken in the planning and design of the facility.

Fear of crime by the users and nonusers of the proposed facility can be estimated using the values of Figure A-11. Check the appropriate values and sum them to rate both the present and proposed facilities.

2.1.4 Emergency Access/Medical and Fire Facilities

Several components must be considered in assessing the ability of the facility to allow emergency access and to support the treatment of both personal health and physical property damage. The most important of these is the adequate availability of access for emergency vehicles, a major design requirement for large-scale pedestrian facilities. Considerations must include adequate numbers of entrances and exits, ample turning radii and sufficient height clearances for various types of emergency vehicles. In many cases this access will be required to obtain the necessary construction permits for the facility. Figure A-12 is used to measure the degree to which a facility supports emergency services.

2.2 Attractiveness of Surroundings

The pleasantness of surroundings for a pedestrian may be measured in terms of pedestrian orientation of the environment, litter control, pedestrian density, and climate control

		Positive		Average		Negative	
Vehicles	Traffic Volume	Low	2	Med	0	High	2
	Traffic Speed	Low	2	Med	0	High	2
	Turning Conflicts	Few	1	Mod	0	Many	1
	One-way Traffic	Yes	1	No	0		--
	Vehicle Mix		--	Mixed	0	High % Trucks Buses	1
Setting	Crosswalks	Marked	1		--	Unmarked	1
	Signalization	Veh and Ped	1	Veh Only	0	None	1
	Sight Distance	Good	1	Mod	0	Poor	1
	Lighting	Good	1	Mod	0	Poor	1

Sum the column values: Positive = ____ Average = 0 Negative = ____

Total ACCIDENT THREAT SCORE is Positive Sum - Negative Sum = ________

Figure A-10. Accident threat concern scoring.

	Positive		Average		Negative			
Frequency of Visible Police Patrols	High	4	Mod	0	Low	4		
Pedestrian Density	High	4	Mod	0	Low	2	Very Low	4
Lighting	Good	3	Mod	0	Poor	4		
Visual Connection with Environment	View Outside	1	No View, Spacious	0	Narrow, Stark	2		
Line of Sight	Long	1	Mod	0	Short	1		
Communications	Pull Boxes, No Coin Voice	1	Coin Voice	0	None	1		
Community Awareness Programs	Active	1	None	0				
Vehicle Volume	Low	1	Mod	0	High	.5		
Idlers (drunks, panhandlers, teenagers)	Very Few	2	Few	0	Med	1	Many	2
Clutter (confusion, distaste)	Little	1	Some	0	Much	.5		
Litter	None	1	Some	0	Much	1		

Sum the column values: Positive = ____ Average = 0 Negative = ________.

Total CRIME CONCERN SCORE is Positive Sum + Negative Sum = ________ , ÷ 2 = ________.

Figure A-11. Crime concern scoring.

and weather protection. The surroundings are much more important for pedestrian transportation than for other modes because the pedestrian interacts directly with his environment. Measurement techniques for these variables are described in the following sections.

2.2.1 *Pedestrian-Oriented Environment*

Check off the boxes in the following that describe the facility being evaluated. For further commentary on planning attractive pedestrian environments, the reader is directed to Antoniou (1971), Benepe (1965), Morris and Zisman (1962), Nelson (1974), and Owen (1969).

Positive Impacts

Amenities

Small park or plaza	☐
Water fountain, artificial waterfall, or splashing water	☐

The Arts

Theater (open or enclosed)	☐
Mural(s) or other graphic art	☐
Sculpture	☐
Strolling musicians and performers	☐
Street artists, handcrafts	☐
Tasteful, unobtrusive background music in selected areas	☐

Buildings

Interesting architecture; creative entrances	☐
Renovation, restoration, or good paint job	☐

Communications

Attractive mailboxes	☐
Attractive telephones	☐
Clock or sundial	☐

Exhibits

Exhibits, displays or demonstrations	☐
Monument or statue	☐

Nature

Trees	☐
Gardens	☐
Floral exhibits, with seasonal variety	☐
Songbirds	☐

Outdoor Eating

Sidewalk cafes	☐
Food pushcarts	☐

Physical Comfort

Long, deep (30-inch), wooden benches	☐
Steps or ledges on which to sit	☐
Drinking fountains	☐
Leaning posts (walls, pillars, flagpoles)	☐

Retail Outlets

Street vendors (flowers, sundries)	☐
Colorful or interesting shop fronts	☐
Bookstore(s)	☐
Newsstand	☐

POSITIVE IMPACT SCORE is sum of boxes checked = ______

Negative Impacts

Caged pedestrian overpasses	☐
Utility poles and wires	☐
Automobile intrusion, extensive curb parking, parking lots, or garages	☐
Long, monotonous frontages (such as factory or warehouse walls)	☐
Vacant lots or buildings	☐
Billboards or distasteful advertising	☐
Long sections of tall (higher than 6 feet, 1.8 meters) fences	☐
Narrow walkway	☐
Noise	☐
Motor vehicles or industrial odors	☐

NEGATIVE IMPACT SCORE is sum of boxes checked ____ x 2 = ____

Total PEDESTRIAN ENVIRONMENT SCORE is Positive Impact Score - Negative Impact Score = ____, ÷ 2 = ____, -5 = ____.

2.2.2 *Litter Control*

Auto-free zones are more expensive to keep clean than equal areas of conventional city streets, partly because wind generated by moving traffic causes dust and litter to be deposited at the edges of the road, where it can be swept up by a street cleaning truck. Also, pedestrians in vehicle-free zones have more time to indulge in litter-producing activities, such as eating and smoking, so more litter is generated (Dalley, 1973). Further, less energy intensive but more costly manual sweeping methods often have to be used to clean malls instead of or in addition to the mechanized process. Thus, it is particularly important to carefully evaluate the litter potential of pedestrian separation facilities because a "clean" atmosphere encourages a "do-not-litter" attitude.

The Urban Institute, in *How Clean Is Our City?* (Blair and Schwartz, 1972) defined four levels of cleanliness for streets and alleys, based on 400 photographs of scenes representative of the range of litter conditions in the District of Columbia. These photographs were judged independently by 19 persons, and those on which there was complete or nearly complete agreement were selected as reference standards. These photographs, which constitute Exhibits 4 and 5 (pp. 20-23) of *How Clean Is Our City?* are shown in Figures A-13 and A-14 to facilitate the evaluation of cleanliness of pedestrian facilities.

Points have been assigned to the different conditions, focusing on the conditions between 1.5 and 2.5 (midway between conditions 1 and 2, and 2 and 3, respectively) as

	Positive		Average		Negative			
Emergency Vehicle Access	Good	3	Partial	0	Poor, None	4		
Other Traffic	None	2	Little	0	Mod	1	Heavy	2
Pedestrian Density	High	1	Mod	0	Low	1		
Lighting	Good	1	Mod	0	Poor	1		
Communications	Pull Boxes, No Coin Voice	1	Coin Voice	0	None	2		
Medical Aid Stations	Yes	1	No	0				
Fire Extinguishers	Yes	1	No	0				

Sum the column values: Positive = _____ Average = 0 Negative = _______

Total EMERGENCY SCORE = Positive Sum - Negative Sum = ___________.

Figure A-12. Emergency scoring.

CONDITION 1: CLEAN

CONDITION 2: MODERATELY CLEAN

CONDITION 3: MODERATELY LITTERED

CONDITION 4: HEAVILY LITTERED

Figuer A-13. Examples of street litter conditions.

CONDITION 1: CLEAN

CONDITION 3: MODERATELY LITTERED

CONDITION 2: MODERATELY CLEAN

CONDITION 4: HEAVILY LITTERED

Figure A-14. Examples of alley litter conditions.

the most critical, highest cost-effectiveness range. The scoring procedure is as follows:

	Condition	Points
1.	Clean: free of unsightly dirt and litter	0
1.5	Almost clean: probably the most efficient goal for cities to aspire to meet	−1
2.	Moderately clean: slight accumulations of dirt and litter	−4
2.5	Littered	−7
3.	Moderately littered: significant accumulations of dirt and litter	−8
4.	Heavily littered: heavy accumulation of litter and rubbish in and near street (or promenade)	−10

LITTER CONDITION SCORE selected = _______.

Chewing gum that has been discarded on a walking surface sticks to it, captures dirt, melts, and eventually hardens into a black circle that is impossible to remove by almost any other means than steam cleaning. If this condition exists on the facility being evaluated, subtract 1 or 2 from the score selected, depending on the amount of gum residue present.

In addition to an index of the accumulation of litter present on a particular pedestrian facility, placement and collection of litter from trash baskets is important. It is frustrating for a pedestrian who does not want to litter to be unable to find a trash basket when one is needed. An equally bad situation is when the trash cans are filled to the brim, and anything left on top is likely to fall off or blow away. The following scale provides an indicator of the effectiveness of trash receptacle placement.

Situation	Points
No trash baskets	0
Trash baskets emptied very rarely	1
Some trash baskets but they are not sufficient, are unattractive, or are infrequently collected	5
Adequate placement of trash baskets but they are not necessarily attractive	8
Adequate placement of attractive or innovative trash baskets	10

Control Condition Score selected = _______

Total LITTER CONTROL SCORE is Litter condition + Control condition = _______.

2.2.3 Density

Smaller densities are usually preferable to greater densities, because the pedestrian may walk at the speed and direction he desires, not having to worry about conflicts with others. Also, at low densities, a person may stop to look into a store window without fear of having someone walk into him from behind. However, beyond a certain point, approximately 1,200 to 1,400 sq ft (111 to 130 m^2) per person, a mall will appear empty and hence less desirable than a mall full of activity. This reversal of the density curve was best expressed by Morris (1967): "It is better to have too many people for the walkway than to have a broad expanse of concrete with no pedestrians." At high densities, however, crowding occurs, causing conflicts, frustration, delay, speed and direction changes, and perhaps even claustrophobia in some. As considered here, density pertains only to inputs on the pedestrians' level of comfort; the delaying effect of density is covered under pedestrian travel time (1.1.1). Walking speed changes caused by density are only significant at very high densities anyway, those that give zero points on the scale presented later herein.

Pedestrian density will vary considerably throughout the day, usually reaching a peak during the lunch or heaviest shopping hours, and will probably reach zero from 2 to 4 a.m. To determine representative density for a pedestrian facility, it is appropriate to borrow a technique from highway planning and evaluate the 30th highest hour for the year (Wohl and Martin, 1967, Sec. 6.2). Unfortunately, pedestrian counts are much more expensive to take than freeway vehicle counts, because the state of the art for pedestrian counters is very primitive, whereas vehicle counters are quite sophisticated. Thus, observers are almost always required to count pedestrians, whereas they are needed only for counting turning vehicles at intersections. Hence, for lack of complete pedestrian traffic data, an educated guess will have to be made as to when the 30th highest hour occurs. Local merchants may be able to provide a good approximation, or pedestrian volume can be adequately estimated as follows. If the observer knows (or thinks) that the heaviest volumes occur during the weekday lunch hours, that fall is the busiest season and October the biggest month, the 30th highest hour could be a weekday lunchtime in late September, November, or December.

It is simple to measure pedestrian density when there are boxes of known area in the pavement. The ordinary boxes on sidewalks formed by the gaps allowed for concrete expansion and contraction are fine. On Sparks Street, these boxes are 7 ft 10 in. on a side, or 60.84 sq ft (5.65 m^2) in area, rounded to 60 sq ft for convenience. If there are no expansion joints, boxes can be drawn on the surface with chalk. To determine average densities, establish an appropriate grouping of between 4 and 40 boxes, depending on the pedestrian density and speed, pedway geometry, and the position of the observer. Then count the number of people within the group of boxes at various times. Multiply the area of each box by the number of boxes and divide by the number of pedestrians in the boxes to determine the amount of space per person.

On a large mall where people are traveling in all directions, density can vary tremendously from one minute to the next. This is because people often travel in groups, and if the group is walking slowly, pedestrians become stuck behind it, temporarily increasing the density, which will only fall again after the group passes. Thus, density must be observed continuously over a certain time period (probably at least 15 min) to be meaningful. Determine the typical maximum density for the time observed; i.e., the density level reached at least three times during a 15-min observation period.

Fruin (1971) derived levels of pedestrian service for design of terminal facilities for the Port Authority of New York and New Jersey. These have been expanded by Pushkarev and Zupan (1975b) into standards for crowding and impeded flow in pedestrian facilities. This work has been used as a starting point, but new criteria were developed by the researchers based on observations of pedestrian flow, crowding, and conflicts on the Sparks Street Mall. One major difference is that in transportation terminals pedestrian flow is often directed to and from the vehicles, whereas on a mall pedestrians walk in all directions. People also walk much faster in transportation terminals than on malls.

The 10-point allocation system developed during this process is recommended for evaluating pedestrian densities. The number of pedestrians per 7 ft 10 in. (2.4 m) square box provides an insight as to how the scores were developed and can be applied.

No. of Persons per 7′10″ Square Box	Amount of Space (sq ft)* per Person	Level of Service	Score
6 or more	10 or less	Measurable delay, numerous conflicts	−10
5	12	Crowded	−6
4	15		−4
3	20	Constrained	0
2	30		4
1	60	Impeded	7
½	120		9
⅓	130	Free flow	10
1/23 or less	1400 or more	Empty	6

* To convert square feet to square meters, multiply by 0.0929.

DENSITY SCORE selected = _______

One can see from the point system that discomfort due to density is gradual between 180 and 30 sq ft (16.7 and 2.8 m^2) per person, and then rises rapidly until 10 sq ft (0.9 m^2) per person, the critical point, is reached. At 1,400 or more sq ft (130 m^2) per person the area appears empty, and much of the pleasure of being around other people is lost.

2.2.4 *Climate Control and Weather Protection*

This item considers heating, cooling, ventilation, and protection from the elements. Inasmuch as outdoor facilities are rarely artificially heated or cooled, higher scores will occur on this variable for climate-controlled indoor facilities. Even indoor facilities that are not climate controlled provide some protection from the elements. For a discussion of traveler comfort with various heating, air conditioning, and ventilation conditions, see Cantilli (1972). However, increased attention has been given to energy conservation since the time of Cantilli's research, and the ratings presented in the following place the optimum temperature in winter 4 F (2.2 C) lower than that in his thesis.

- Heating. In winter, to what temperature is the facility heated?

Temperature	Points
78 F (26 C) or warmer	2
73 F (23 C)	4
68 F (20 C)	5
63 F (17 C)	4
58 F (14 C)	2
53 F (12 C), or unheated	0

HEATING SCORE selected = _______.

- Air Conditioning. In summer, to what temperature is the facility cooled?

Temperature	Points
57 F (14 C) or colder	0
62 F (17 C)	2
67 F (19 C)	4
72 F (22 C)	5
77 F (25 C)	4
82 F (28 C)	2
87 F (31 C) or warmer	0
No artificial cooling	0

AIR CONDITIONING SCORE selected = _______.

- *Ventilation.*

Ventilation Rate or Condition	Points
Outdoor facility	5
2 Ft^3 fresh air/min/ft^2 floor space	5
1½ Ft^3 fresh air/min/ft^2 floor space	4
1 Ft^3 fresh air/min/ft^2 floor space	2
½ Ft^3 fresh air/min/ft^2 floor space	0
No artificial ventilation	0

VENTILATION SCORE selected = _______.

- *Protection.* Are pedestrians protected from

	YES	NO
Direct sun?	1	0
Gusts of wind?	1	0
Precipitation?	1	0
Blown rain coming in at a slant?	1	0
Snowdrifts or puddles?	1	0

PROTECTION SCORE is sum of values in boxes checked = _____.

Total CLIMATE AND WEATHER SCORE is Heating Score + Air Conditioning Score + Ventilation Score + Protection Score = _______, -10 = _______.

2.3 Environment/Health

2.3.1 Effects of Air Pollution

Pollution results from the introduction of wastes into the environment in greater concentrations than can be absorbed over a given period of time. Motor vehicles contribute significantly to a number of major air pollutants. Because pedestrian facilities are structured around a basically nonpolluting mode of transportation (walking), they present opportunities to reduce motor vehicle pollution by decreasing the number of vehicle-miles traveled, and also by reducing or eliminating time and space conflicts between pedestrians and vehicles, thereby improving traffic flow. Such results would also reduce the consumption of fuel and oil and the wear on brake linings.

The pollutants generated by motor vehicles and considered here for their effects on humans and on property are:

- Carbon monoxide (CO)—resulting from incomplete combustion and injurious to human health at concentrations generated by heavy traffic volumes.
- Hydrocarbons (HC)—actually a group of organic gases such as ethylene, some of which pose serious threats to plant, animal, and human health in sufficient concentrations, as well as participating in the "smog" reaction with resultant eye and lung irritation and visibility restrictions.
- Nitrogen oxides (NO_x)—formed by high-temperature or high-pressure combustion processes and participate in photochemical reactions resulting in smog formation.
- Sulfur dioxide (SO_2) and sulfuric acid (formed when SO_2 comes in contact with water)—are very toxic materials highly injurious to human health (especially to persons with respiratory problems), plant life, and property.
- Particulate matter—dust, soot, asbestos from brake linings, tire rubber, and others that can cause damage to humans, plants, buildings, and other personal property.

Damage to property includes damage to plant life, buildings, clothing, and other personal property. The results of air pollution damage to property are more frequent replacement and renovation rates such as replanting, cleaning, and refinishing. Due to the complex nature of pollution damage effects, and the greater concentration of past research on danger to humans, considerably less is known about the specific impacts of pollution on property as described. However, the range of air pollutant concentrations that affect human health and psychology is generally coincident with the range of pollutant concentrations that affect property. Thus, the need for a relative scale value can be met by a single score for both property damage and human impacts.

The effects of air pollution result from the subject experiencing the ambient air quality, which is determined by: the number of, and distance from, air pollutant sources; the specific types and amounts of pollutants emitted; the physiographic characteristics of the area; and complex meteorological conditions. Analysis of these interacting characteristics to determine the air pollutant actually experienced by a person or an item of property is possible but not within the scope of the evaluation required here. Furthermore, even if the ambient concentrations experienced were accurately predicted, threshold reactions, synergistic effects, and varying responses of different individuals and materials to the same pollutants would make the effects analysis too complex for the evaluation of pedestrian facilities. Thus, to provide a practical evaluation technique, it was decided to assume a one-to-one relationship between motor vehicle emissions and health and property damage.

The user should be aware that this evaluation is very general. It cannot be used in place of an expert evaluation of the specific site and project plan to accurately determine the change in air pollution levels or their resulting effects. However, it does provide a reasonable method to allow an approximate comparison of alternate pedestrian facilities.

Determination of Pollutant Level Changes.

1. Define the area over which motor vehicle traffic will be significantly affected (the project area). A very small project area will not take all changes into account, whereas a very large area will make the resulting pollutant emissions seem insignificant. The area should be defined in terms of miles of roadway. This evaluation can be done separately for each road or section of road involved, with separate scores, for each section of road, added to or subtracted from the total score. Separate sections can be evaluated individually and their scores averaged if desired.
2. Determine the annual average traffic volume for each project area road segment and express it in terms of vehicle-miles traveled (VMT) per day. Estimate the comparable values for each project alternative.
3. Determine average speed for each area road segment. The average speed takes stop lights and the like into account, as well as the speed limit (see Sec. 1.2.1.1 for a discussion of speed determination). Again, if different road sections have different average speeds, the evaluation can be done separately and the scores averaged. This separate consideration might be beneficial in cases where some type of vehicle traffic impediment (such as a STOP sign) is removed on one street.
4. Determine the present (no project) emission level for each of the five pollutants by multiplying the daily VMT by the emission factors given in Table A-1 * for the project year and adjusted by the speed correction factors given in Figure A-15.†
5. Determine the future (with project) emissions for each of the five pollutants in the same manner. Emission factors for the same year should be used so that improvements in emission controls are not counted as project benefits.
6. Separately add the weighted emissions for the present case and the future case to get a weighted sum for each in the same units. The weighting factors to be used are: CO = 1; HC = 125; SO_x = 15.3; NO_x = 22.4; particulates = 21.5. These factors are derived (Walther, 1972) from the national ambient air quality standards that were

* Supplement No. 2 for "Compilation of Air Pollutant Emission Factors," 2nd Ed. U.S. Environmental Protection Agency, Research Triangle Park, N.C. (Sept. 1973) Table 3.1.1-1, p. 3.1.1-6.

† Ibid., Figure 3.1.1-1, p. 3.1.1-7.

TABLE A-1

AVERAGE EMISSION FACTORS FOR HIGHWAY VEHICLES BASED ON NATIONWIDE STATISTICS

	Carbon monoxide		Hydrocarbons				Nitrogen oxides (NO_x as NO_2)		Particulates				Sulfur oxides (SO_2)	
			Exhaust		Crankcase and evaporation				Exhaust		Tire wear			
Year	g/mi	g/km	g/mi	g/km	g/mi	g/km	g/mi	g/km	g/mi	g/km	g/mi	g/km	g/mi	g/km
1965	89	55	9.2	5.7	5.8	3.6	4.8	3.0	0.38	0.24	0.20	0.12	0.20	0.12
1970	78	48	7.8	4.8	3.9	2.4	5.3	3.3	0.38	0.24	0.20	0.12	0.20	0.12
1971	74	46	7.2	4.5	3.5	2.2	5.4	3.4	0.38	0.24	0.20	0.12	0.20	0.12
1972	68	42	6.6	4.1	2.9	1.8	5.4	3.4	0.38	0.24	0.20	0.12	0.20	0.12
1973	62	39	6.1	3.8	2.4	1.5	5.4	3.4	0.38	0.24	0.20	0.12	0.20	0.12
1974	56	35	5.5	3.4	2.0	1.2	5.2	3.2	0.38	0.24	0.20	0.12	0.20	0.12
1975	50	31	5.0	3.1	1.5	0.93	5.0	3.1	0.38	0.24	0.20	0.12	0.20	0.12
1976	44	27	4.3	2.7	1.3	0.81	4.8	3.0	0.38	0.24	0.20	0.12	0.20	0.12
1977	37	23	3.7	2.3	1.0	0.62	4.3	2.7	0.38	0.24	0.20	0.12	0.20	0.12
1978	31	19	3.2	2.0	0.83	0.52	3.8	2.4	0.38	0.24	0.20	0.12	0.20	0.12
1979	27	17	2.7	1.7	0.67	0.42	3.4	2.1	0.38	0.24	0.20	0.12	0.20	0.12
1980	23	14	2.4	1.5	0.53	0.33	3.1	1.9	0.38	0.24	0.20	0.12	0.20	0.12
1990	12	7.5	1.3	0.81	0.38	0.24	1.8	1.1	0.38	0.24	0.20	0.12	0.20	0.12

NOTE: This table reflects interim standards promulgated by the EPA Administrator on April 11, 1973, and in July 1973.

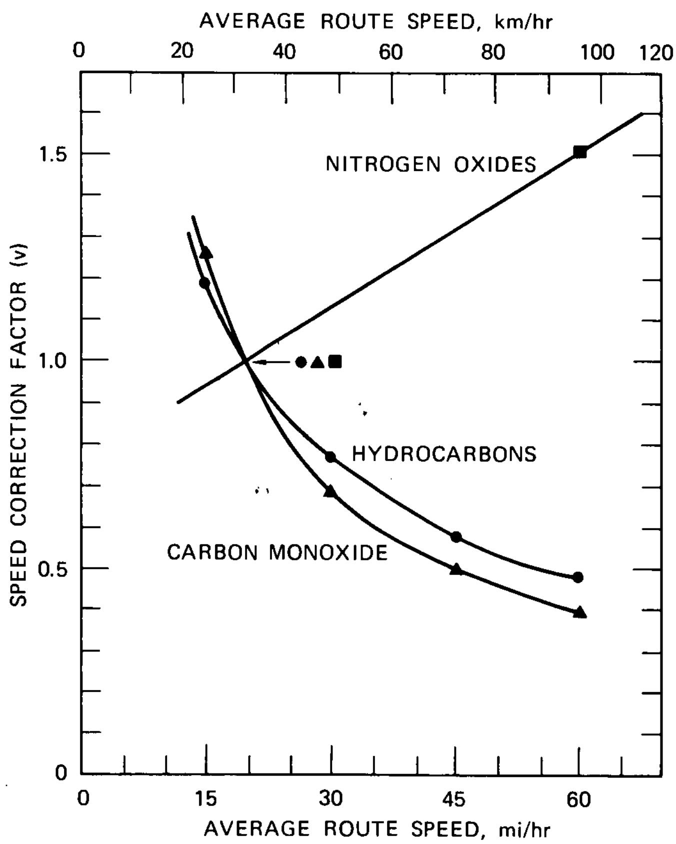


Figure A-15. Average speed correction factors for all model years. (Curves developed from test of pre-1968 (uncontrolled) vehicles. Recent tests indicate their approximate applicability to controlled vehicles, including those equipped with catalytic devices.)

promulgated to prevent health and welfare damages. Thus, the assumption is that a person (or a plant or property) can experience 125 units of concentration of carbon monoxide and get the same relative level of damage as one unit concentration of hydrocarbons.

7. Calculate the percent change in total emissions of project situation from no-project situation by using

$$(E_{\text{project}} - E_{\text{present}})/E_{\text{present}} \qquad \text{(A-16)}$$

8. Obtain the final score from Figure A-16.

Sample Application.

Present (no project)

1. Wrongway Avenue: ½ mi
   Easy Street: ¼ mi
   Roundabout Drive: ⅔ mi
   Total = 1 5/12 mi
2. Wrongway Ave.: 10,000 v/day × ½ mi = 5,000 veh-mi/day
   Easy St.: 2,000 v/day × ¼ mi = 500 veh-mi/day
   Roundabout Dr.: 1,500 v/day × ⅔ mi = 1,000 veh-mi/day
   Total = 6,500 veh-mi/day
3. Average speed over all streets = 30 mph.
4. CO = 50 g/mi × 6,500 veh-mi/day × 0.7
   = 227,500.00 g/day
   HC = (5.0 + 1.5 g/mi) × 6,500 mi/day × 0.75
   = 31,687.50 g/day
   SO_x = 0.20 g/mi × 6,500 mi/day
   = 1,300.00 g/day
   NO_x = 5.0 g/mi × 6,500 mi/day × 1.1
   = 35,750.00 g/day
   Part. = (0.38 + 0.20 g/mi) × 6,500 mi/day
   = 3,770.00 g/day

5. Does not apply; only the present case is being considered.
6. (1 × CO) + (125 × HC) + (15.3 × SO_x) + (22.4 × NO_x) + (21.5 × Part.) = (227,500) + 125(31,687.5) + 15.3(1,300 × 22.4(35,750) + 21.5(3,770) = 5,090,183 effect equiv. g/day = $E_{present}$

Future (with project). Possibly a pedestrian overpass replacing a mid-block pedestrian crossing on Wrongway Avenue. This attracts traffic off Easy Street and Roundabout Drive, and also increases average speed because of the stop eliminated.

1. Wrongway Avenue: ½ mi
   Easy Street: ¼ mi
   Roundabout Drive: ⅔ mi
   Total = 1 5/12 mi
2. Wrongway Ave.: 12,000 v/day × ½ mi = 6,000 veh-mi/day
   East St.: 1,000 v/day × ¼ mi = 250 veh-mi/day
   Roundabout Dr.: 500 v/day × ⅔ mi = 333 veh-mi/day
   Total = 6,583 veh-mi/day
3. Average speed over all streets = 33 mph.
4. Does not apply; this is a planned project.
5. CO = 50 g/mi × 6,583 mi/day × 0.63 = 207,364.50 g/day
   HC = 6.5 g/mi × 6,583 mi/day × 0.70 = 29,952.65 g/day
   SO_x = 0.20 g/mi × 6,583 mi/day = 1,316.60 g/day
   NO_x = 5.0 g/mi × 6,583 mi/day × 1.20 = 39,498.00 g/day
   Part. = 0.58 g/mi × 6,583 mi/day = 3,818.14 g/day
6. (1 × CO) + (125 × HC) + (15.3 × SO_x) + (22.4 × NO_x) + (21.5 × Part.) = (207,364.5) + 125(29,952.65) + 15.3(1,316.6) + 22.4(39,498) + 21.5(3,818.14) = 4,938,435 effect equiv. g/day = $E_{project}$
7. $\frac{E_{project} - E_{present}}{E_{present}} = \frac{4{,}938{,}435 - 5{,}090{,}183}{5{,}090{,}183}$ = −3 percent (i.e., 3 percent lower emissions).
8. From Figure A-16, a −3 percent emissions change gives a score of +5 for effects of air pollution.

2.3.2 *Noise Impacts of Motor Vehicles*

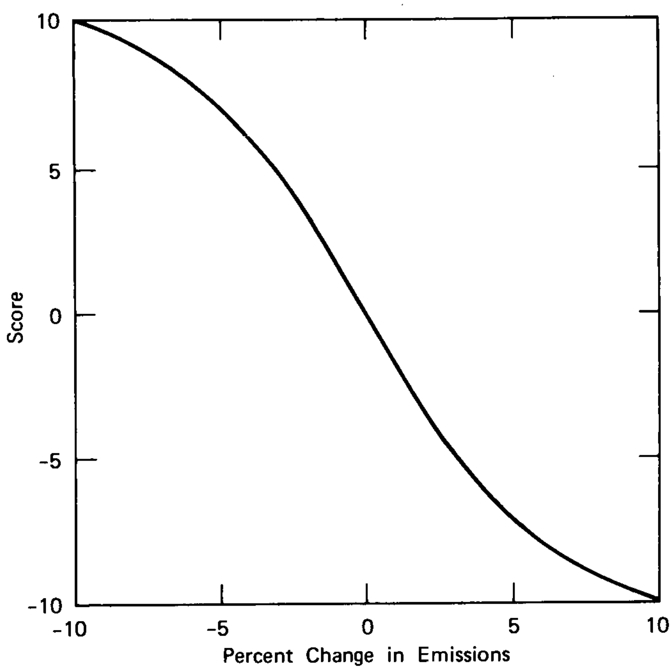
When pedestrians were asked what displeased them about their walking environment (Eckman et al., 1975), 26 percent expressed displeasure with noise, 14 percent with dirt or litter, and 11 percent with air pollution. Noise may be simply defined as any sound that is undesired by the recipient. The major function of the human auditory system is to select information-bearing components in a sound wave. Thus, the masking of speech is the most important effect of noise on man (Kryter, 1972).

Speech masking is not the only effect, however. Various sound levels are capable of producing annoyance, sleep disturbance, and declines in property value near noise sources. More seriously, noise can produce hearing losses, vasoconstrictive effects in the circulatory system, muscular tension, sweating, metabolic change, nausea, headaches, drowsiness, and respiratory irregularities.

Aspects of noise considered when measurement is made are the magnitude of the noise, the frequency distribution, and the variation and duration over time. The most commonly used measurement scale is the A-weighted decibel scale, db(A), which measures sound level in a way that emphasizes frequencies in a manner similar to human auditory systems. It was developed largely for use in measurement of motor vehicle noise (Berry et al., 1974).

Although hearing losses begin at 85 db(A) with prolonged exposure to such noise levels over several years and serious losses begin at 90 db(A) over a similar period (Dickerson et al., 1970), motor vehicle traffic noise seldom offers such physical danger to pedestrians. What it does do is annoy, cause discomfort, and interfere with speech. Heavy trucks and buses produce sound levels as high as 85 db(A) on city streets, as observed during this research. Figure A-17 shows comparative sound levels from a range of noise sources (Berry et al., 1974, Fig. 5-3, p. 214).

Because dangerous sound levels are seldom encountered by pedestrians, a scaling system to measure the impact of noise for pedestrian facilities can be restricted to the meaningful levels of sound usually encountered. Some general



Emission increases greater than +10% score -10
Emission decreases greater than -10% score +10

Total Air Pollution Score is value indicated by graph based on percent change in Emissions = ____.

Figure A-16. Scoring graph for air pollution effects on human health and property.

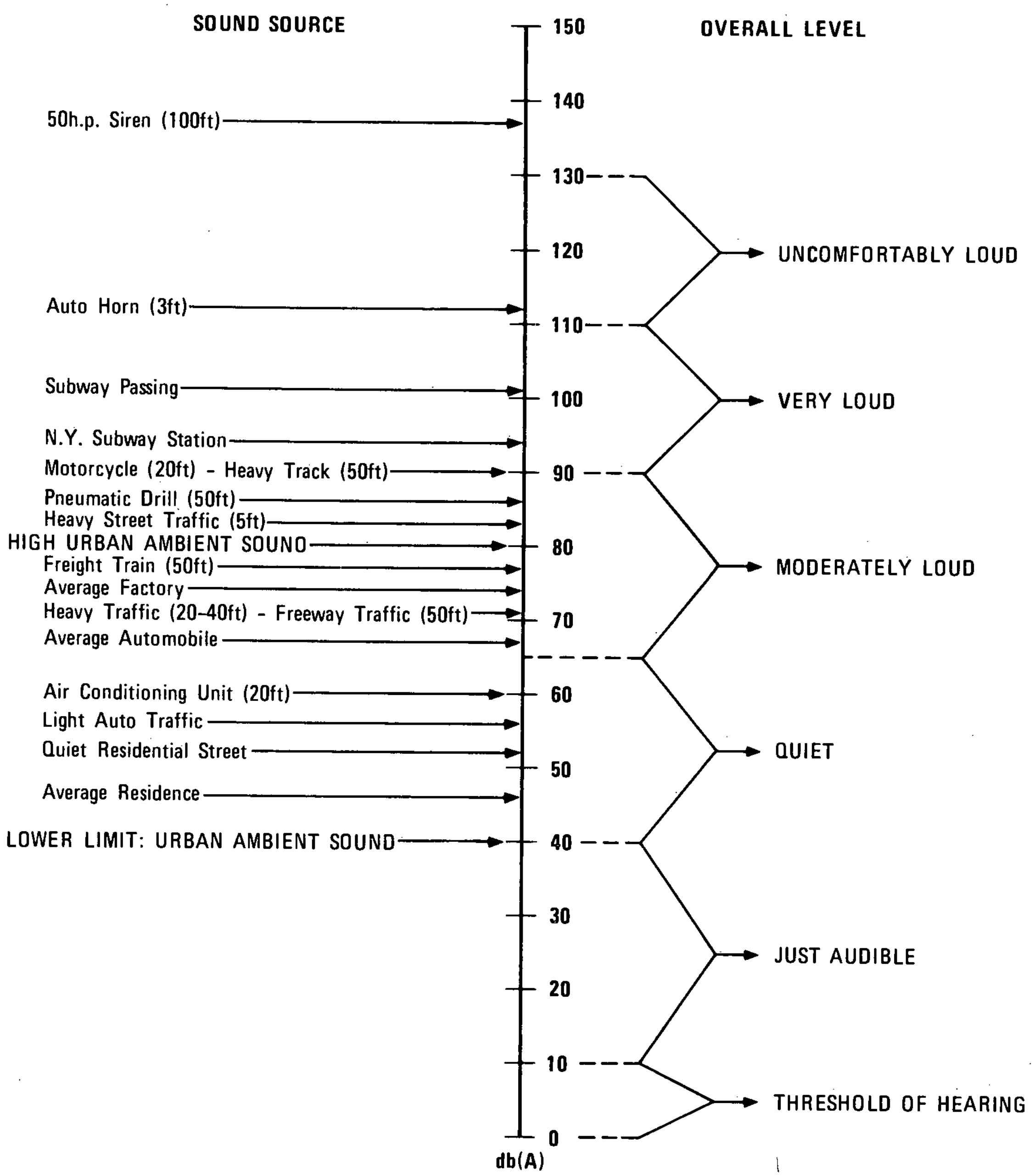


Figure A-17. Comparison of sound sources and noise levels.

values that may be encountered in typical types of pedestrian facilities are as follows:

70 db(A)	An open overpass over heavy traffic.
65 db(A)	A busy sidewalk on a commercial street allowing all types of vehicles with 70- to 85-db(A) peaks.
60 db(A)	An enclosed overpass over heavy traffic or a busy mall with buses and delivery traffic (with 70- to 85-db(A) peaks from those vehicles).
55 db(A)	An open overpass over light traffic or a busy mall with no vehicle traffic and light background noise.
50 db(A)	A quiet residential street.

The selected sound range for scaling pedestrian facilities is from 40 db(A) (a practical minimum) to 90 db(A) (a reasonable maximum). The upper value is exceeded by some subway-generated noises and other special noises, but speech is generally impossible beyond that level, so it is a practical upper bound for pedestrian facility evaluation.

Sound level measurements in decibels using the A scale should be taken at a sufficient number of points to obtain a representative noise level for an existing facility. Estimates of the noise level for proposed facilities can be made by taking sound measurements from comparable facilities, or examining Figure A-17 and the preceding list to select a reasonable value for the proposed facility. The following scale or formula (Eq. A-17) can then be used to evaluate the change in noise levels:

90 db(A)	77.5 db(A)	65 db(A)	52.5 db(A)	40 db(A)
-10	-5	0	+5	+10

Any noise level over 90 db(A) scores -10
Any noise level under 40 db(A) scores +10

$$\text{Total NOISE SCORE} = -10 + \left[(90 - \text{observed or estimated noise level}) \times 0.4\right]$$

$$= \_\_\_\_\_\_\_\_ \qquad \text{(A-17)}$$

2.3.3 *Health Effects of Walking (Exercise, Fatigue)*

The primary anticipated health benefits of walking, jogging, running, or bicycling are improvements in physical health because of the physiological effects of exercise. Because our society has become quite sedentary, our major health concern is toward coronary heart disease (CHD) and its prevention or control. The classical concept is that over-all energy expenditure reduces the incidence of CHD; and the more exercise, the lower the risk.

Unfortunately, medical evidence being developed by current research strongly suggests that exercise must be vigorous, must be of significant duration (20 to 40 min) and must be regular (three or more times per week) to be effective in lowering the risk of CHD. Vigorous activity is usually defined relative to kilocalories consumed per minute; the required minimum threshold is about 6 to 7 kcal per min. This is comparable to walking briskly at 4 to 5 mph (6.4 to 8 kph). Jogging, running, bicycling, tennis, and swimming all generally exceed the minimum threshold, usually substantially; for example, running at 10 mph (16 kph) consumes 18 to 20 kcal/min. But ordinary walking, less than 4 mph (6.4 kph), is not sufficiently vigorous.

The medical point of view toward exericse is typified by the following statement from a report based on a study of middle- and upper-level British civil servants that showed a significant relationship between vigorous leisure-time activity and reduction in CHD (Morris et al., 1973): "Habitual vigorous exercise during leisure-time reduces the incidence of CHD in middle age among male sedentary workers. Vigorous activities which are normal for such men are sufficient. Training of the heart and cardiovascular system is one of the mechanisms of protection against common risk factors and the disease."

In spite of the fact that ordinary walking is not sufficiently vigorous to be effective in preventing CHD, such exercise has other benefits. These include caloric expenditure assisting in weight control, muscle tone development, reduced blood pressure, and reduction of psychological stress in many pedestrian environments. There is also a generally brighter mental outlook induced by attractive and comfortable pedestrian facilities. Against these must be weighed the possible disbenefits of induced fatigue (particularly the elderly), exposure to air pollution (particularly CO), and psychological stress if vehicles or excessive noise are present. Assessing the impact of a pedestrian facility on human health is therefore expressed in terms of those subelements that contribute (or detract) from the physical and mental well-being of its users.

Check the boxes in Figure A-18 that apply to a given pedestrian facility to determine its score.

2.3.4 *Conservation of Resources*

Precise identification of all resources involved in construction, maintenance, and use of a pedestrian facility would be an extremely time-consuming process unnecessary for the intent of this methodology. The scoring system presented is devised primarily to distinguish between alternatives, and a checklist of resources utilized relative to their scarcity is the indicator to be used.

Five major categories of resources were considered; the most significant elements in each category relative to pedestrian facilities were identified. They are:

- Energy resources (direct)—crude oil and related products; natural gas; hydropower; coal.
- Manufactured materials (indirect energy use)—metals and metal products; lumber and wood products.
- Natural resources (nonenergy)—water supply; soil quality, stability, and contour.
- Human resources—labor.
- Private and public services—sanitary services, communication services (transportation services are considered separately in Sections 1.1 to 1.3).

An estimate of the use should be made for each major resource category relative to the reviewer's concept of "ordinary" use of the resource in general pedestrian facilities. If very little use of a resource is made, check the box labeled "low" for that resource. If the amount of a resource category used seems significantly higher than comparable pedestrian facilities, check the box labeled "high." Otherwise check the box labeled "mod" (for moderate). The internal weights of resource categories below indicate the relative availability, renewability, or reusability of the resources considered.

	Positive		Negative
Direct energy	Low 4	Mod 0	High 4
Manufactured materials	Low 3	Mod 0	High 3
Natural resources	Low 1	Mod 0	High 1
Human labor	Low 1	Mod 0	High 1
Services	Low 1	Mod 0	High 1

Sum the columns: Positive = ____ Negative = ____

Total CONSERVATION SCORE is Positive Sum - Negative Sum

= ________.

3. RESIDENTIAL/BUSINESS

3.1 Residential Neighborhoods

3.1.1 *Residential Dislocation*

This variable deals subjectively with the out-of-pocket costs and inconvenience to households (property owners and renters) incurred as a result of implementing a pedes-

	Positive		Average		Negative	
Volume of vehicle traffic within 100 ft (30 m) of pedestrians	None	2	Light	0	Mod	1
					Heavy	3
Clear lanes for rapid walkers or joggers	Yes	1	No	0		--
Bicycle paths through or around facility	Yes	1	No	0		--
Improved access to tennis courts, swimming, other physical activity centers	Yes	1	No	0		--
Benches, ledges, and the like, available for rest stops	Yes	1		--	No	1
Adverse weather protection available (prevent exposure, physical discomfort)	Yes	1	No	0		--
Crime rate in area	Low	1	Mod	0	High	2
Aesthetically pleasing environment (conducive to mental health)	Good	1	Mod	0	Poor	2
Noise levels (psychological discomfort)	Low	1	Mod	0	High	2

Sum the columns as indicated: Positive = _____ Negative = _____

Total HEALTH SCORE is Positive Sum - Negative Sum = _______.

Figure A-18. Health effects scoring.

trian facility. The score for this variable will usually be negative or zero unless special circumstances are present. The out-of-pocket costs considered include:

- Movement of household goods and furnishings.
- Temporary living expenses (housing, food, transportation).
- Residence renovation in new location to establish a comparable living environment.
- Cleanup and repair of residence at present location if movement is not required (stimulated pride of ownership).
- Property adjustments (such as fences) if property boundaries are changed by facility.

Inconvenience to those required to move includes time lost due to the movement and loss of access to friends, neighbors, schools, shopping, and neighborhood activities. Special circumstances that could offset some of these costs (for disbenefits) might be a reimbursement policy that compensates beyond the actual out-of-pocket costs, or the availability of significantly better living quarters at comparable costs for those forced to move.

The final score for this factor is obtained by considering the number of households impacted, the costable and noncostable components previously listed, the reimbursement policy, and any special circumstances as follows. A household index is selected from the following:

No. of Households Impacted	Index Value
0	0
1-2	1
3-5	2
6-10	3
11-20	4
21+	5

1. Household index value selected = ______.
A reimbursement index is obtained using the following:

Costable Impact Types	Reimbursement Policy 0%	50%	100%
Movement of goods	4	2	0
Temporary living expenses	3	1.5	0
Residence renovation (moved to)	1	0.5	0
Residence renovation (stay)	1	0.5	0
Property adjustment (stay)	1	0.5	0

2. Reimbursement index is sum of values in boxes checked = ______ .

A special circumstances index should be selected to range in value from 0 (no special circumstances) to 10 (exceptional social and reimbursement policies).

Points (0-5) for social policy such as housing = ______.
Points (0-5) for excess reimbursement policy = ______.
3. Circumstances index is sum of values chosen = ______.

The final score for residential dislocation is obtained by

$$\text{Total RESIDENTIAL DISLOCATION SCORE} = \text{Circumstances index} - \frac{\text{Reimbursement index} \times \text{Household index}}{10} - \text{Household index} \qquad \text{(A-18)}$$

The following descriptors are used to illustrate the scoring method: 15 households impacted; 50% reimbursement policy for household goods movement and living expenses; no reimbursement for other costs (renovation, etc.); good housing program to assist homeowners in finding reasonable dwellings (also at moderate cost for low-income families); household index = 4; reimbursement index = 6.5; circumstances index = 5.

$$\text{Total score} = 5 - \frac{6.5 \times 4}{10} - 4 = -1.6 \text{ (or rounded to } -2).$$

3.1.2 Community Pride, Cohesiveness, and Social Interaction

This variable considers the impacts of proposed pedestrian facilities on neighborhood and community attitudes and personal relationships among residents. These impacts are difficult to assess, in part because of the wide diversity of neighborhood types. A frequent assumption in the past has been a relative homogeneity of neighborhoods; however, in recent years this has been seriously challenged (Lehmann et al., 1974); Warren and Warren, 1975).

Variations of values and interactions within and between neighborhoods strongly suggest survey or interview techniques to adequately assess the impacts of proposed facilities (Kaplan et al., 1972; Ryan et al., 1972). These techniques provide data that cannot be efficiently obtained in any other way, but care must be taken to minimize measurement errors in such data (Lehmann et al., 1974). Detailed attitudes about the proposed project, attitudes toward the community, and the nature of friendship and social interaction patterns can all be examined, as well as attitudes toward alternative proposals.

Probably the most important assessment to be made in evaluating community impact is what degree of adaptation in behavior will be required as a result of the facility. The scoring system presented here is designed to assist in identifying the types of changes that may be caused by a pedestrian facility, and the degree of desirability of such changes.

The researcher should feel free to reassess the relative magnitude of individual changes by modifying the internal weights of each component. These weight modifications should be scaled to keep within the range of +10 to −10.

A total score for this variable is obtained using Figure A-19. The type of impact is assessed and checked for a list of variable components, then the rating columns are summed. The total score is the sum of the favorable points minus the sum of the points for unfavorable outcome.

Component	Rating: Favorable or Improved	Rating: No Change	Rating: Unfavorable or Decline
Interest expressed in project	1	0	1
Access to neighbors and friends	1	0	1
The pedestrian facility as a meeting place	1	0	1
Neighborhood communications (e.g., bulletin boards)	1	0	1
Access to community facilities (e.g., shopping, theaters)	1	0	1
Links to rest of community	1	0	1
Activities planned (e.g., block parties)	1	0	1
Protection of privacy	1	0	1
Fewer motor vehicles	1	0	1
Bicycle/jogging paths	1	0	1

Sum the columns as indicated: Favorable = ____ Unfavorable = ____

Total COMMUNITY PRIDE AND INTERACTION SCORE is

Favorable Sum - Unfavorable Sum = __________.

Figure A-19. Neighborhood/community impacts.

3.1.3 *Aesthetic Impact, Compatibility with Neighborhood*

This variable is used to assess the blending of a proposed pedestrian facility with the physical surroundings of a residential neighborhood. It should only be considered when pedestrian facilities are located in residential areas (for example; sidewalks, paths, pedestrian/bicycle networks).

A checklist of favorable components (Fig. A-20) is followed by a checklist of unfavorable ones (Fig. A-21). The points in each checklist are to be added separately and then combined by subtracting the unfavorable point sum from the favorable point score. Nonapplicable points for a specific facility should be ignored (automatically assigning a neutral value of 0 to that component).

3.2 Commercial/Industrial Districts

The implementation of many, if not most, pedestrian facilities vitally concerns the affected business interests in the vicinity. Not only long-term benefits, but also survival during the construction and transition phase of the project, are major considerations, especially for small local business persons. This section directs special attention to short-term (1 to 5 years) effects on business enterprises from implementation of a pedestrian facility, with the highest ratings assigned for those plans estimated to have the least detrimental effect.

3.2.1 *Gross Retail Sales*

The change in gross sales from last year's performance for the period under question is probably the single most important evaluation criterion for any retailer. Even though different stores will operate at different profit margins, and any increase in sales is likely to be more profitable than average (since the fixed expenses of rent, utilities, and some or all of the payroll have already been recovered), retailers still prefer to evaluate only the change in gross sales. This often reflects business people's reluctance to allow any useful information to get into the hands of competitors. Frequently, however, the store owners are unsure of their actual marginal rate of profit because of the complexity of its determination.

Changes in gross sales result from improved customer access, a greater volume of pedestrian traffic passing the store, improved attractiveness of individual stores or the general area, and changes in the number of visitors, including out-of-town tourists. Individual store owners should be asked to estimate the effect of the facility on their businesses, although they may be reluctant or unable to do so without a trial experimental street closure. Although temporary or trial solutions lack many of the amenities of a permanent installation (such as attractive walking surfaces, trees, benches, and fountains), they can provide an indication of the public and business acceptance of the concept.

A more dependable source for estimates of changes in sales would be a large department store (often part of a chain) that has a research or statistics department, particularly if it has assembled data from previous experiences with similar projects. A chamber of commerce or merchants' association may be able to supply some data, but usually it will direct you to an executive of the major retailing firms, who will be the ultimate source of information.

One rule of thumb that has been developed based on the experience of Norwich, England, in 1967 (Wood, 1970) and Kalamazoo, Mich., in 1959 (Elliot, 1964) relates the increase in sales attributable to a successful facility (change in sales for the affected stores minus the change in sales for the region) to the increase in pedestrian traffic on the mall. Retailers know that sales are directly proportional to foot traffic, and from these two examples the ratio of changes in sales to changes in foot traffic was found to be about 1 to 10. For Norwich, there was a 5 percent improvement in

Structure and shape complementary to neighborhood architecture style	☐
Pleasing and complementary colors or textures	☐
Unobtrusive grade change features (ramps and steps should be masked if possible)	☐
Continuity of pathway with existing pedestrian paths	☐
Blended signing with no glare lighting	☐
Overall lighting complementary to existing light features and intensity levels	☐
Continues existing bicycle/jogging paths	☐
Reduced motor vehicle traffic	☐
Compatible noise levels; 50-55 db(A) in many neighborhoods	☐
Residential privacy protected	☐

Sum of positive components = ________

Figure A-20. Positive compatibility components.

Unpleasant contrast between facility and existing architecture style	☐
Displeasing color or texture contrast	☐
Little pedestrian path continuity	☐
Obtrusive signing	☐
Uncomplimentary lighting and fixtures compared to existing features	☐
Increased motor vehicle traffic, especially trucks	☐
Increased noise levels--over 55 db(A)	☐
Privacy or sleep disturbed by users	☐
Additional litter or vandalism	☐
Fences, poles, or wires	☐

Sum of Negative Components = ________

Total AESTHETICS AND COMPATIBILITY SCORE is

Positive Sum - Negative Sum = ________.

Figure A-21. Negative compatibility characteristics.

sales that could be attributed to the street closure, and a 45 percent increase in pedestrian traffic. Gross sales in downtown Kalamazoo for 1959, the first year after the mall was completed, increased 15 percent. Retail sales for the county increased 12 percent for that same period, so the sales increase attributable to the mall is 3 percent. Pedestrian traffic on the mall increased 30 percent.

Experience also shows that the rate of sales increases is likely to be limited to the first few years of a mall's existence because the novelty of the installation wears off and another sales attractor will probably be introduced into the region. Stone and Surti (1975) assume that the first five years' increase in sales declines uniformly to zero over five years. In their example, a mall built in 1975 would account for a 15 percent sales increase for 1976 over 1975, 12 percent for 1977 over 1976, 9 percent for 1978 over 1977, 6 percent for 1979 over 1978, 3 percent for 1980 over 1979, and 0 percent for 1981 and subsequent years. Because sales are not expected to decrease beyond the 5-year projection period, the sales increases in the first year and subsequent four years build an increased sales base, attributable to the mall, that should continue for years into the future.

This theory can be supported, rather than its contratheory which is that there would be a decline in sales, because historically, malls have proved to be a stimulus for new construction and investment after they have been in operation for a number of years. It seems most likely that the first year will account for a big surge, and so it is best to consider that year a settling-in-period, and try to estimate the average annual percentage increase in gross retail sales over at least the first two years of operation of the facility. Of course there will continue to be an increase in sales resulting from the pedestrian facility after the first two years, but it is felt that the experience of the first two years is sufficient to characterize the impact of the facility on gross sales.

In summary, then, estimate as accurately as possible the average annual change in retail sales attributable to the pedestrian facility for the first two years. This will be equal to the sales change for the affected stores minus the regional average for the same period. Use this percentage as the retail sales score. Inasmuch as a −10 to +10 scale is being used, indicate as −10 any two-year annual decrease in sales greater than 10 percent, and as +10 any two-year annual increase in sales greater than 10 percent. If projections indicate an expected sales volume decrease of greater than 10 percent, serious consideration should be given to alternatives with less severe impacts on local merchants and business persons.

It is expected that the projection of gross retail sales will be assessed at one time for the area affected by the facility as a whole, rather than scaling up from estimates from particular stores or groups of businesses. However, when the shopowners are contacted to determine their displacement or renovation costs for evaluating variable 3.2.2, they may be asked about their estimates of changes in gross sales, and this may be used as input to this estimation process.

RETAIL SALES SCORE selected = ______.

3.2.2 Displacement or Renovation Required or Encouraged by Facility

This variable consists of the out-of-pocket costs to businesses incurred as a result of implementing the pedestrian facility. Unreimbursed costs from business displacements by the facility should be calculated. This number could be negative if a business were reimbursed more than its actual costs.

The costs of renovation to storefronts should be estimated, including signing (such as the replacement of hanging signs by backlighted signs flush against the building), window displays, and the cleaning and painting of building exteriors, by sandblasting if appropriate. These may be:

- Required, as in the case of signing ordinances.
- "Voluntary" but encouraged by the merchants association and all the larger stores, which might typically be the case for comprehensive cleaning of building fronts.
- Completely voluntary, such as a remodeling of the front window display area.

If only a small number of stores is affected by the facility, or if a thorough evaluation is being made, contact every store and building owner to determine their estimates of the displacement or renovation expenses anticipated. If many businesses are involved, a suitable shortcut procedure is to select typical stores to represent the average, and multiply unit costs by the number of stores in that group, or scale unit costs on the basis of frontage feet, if that seems more accurate. Figure A-22 is intended to aid in assembling the necessary information.

The rating for this variable is based on the ratio of displacement and renovation costs to the anticipated change in gross sales, item 3.2.1. The following scale gives the relationship between this ratio and the point score:

Ratio of Displacements and Renovation Costs to Change in Gross Sales	Point Score
5	−10
4	−7.5
3	−5
2	−2.5
1	−0
0.8	2
0.6	4
0.4	6
0.2	8
0	10

DISPLACEMENT OR RENOVATION SCORE selected = ______.

For example, if a pedestrian facility required no business relocation, storefront renovation costs were $10,000, and building cleaning cost $40,000, while the average annual sales increase attributable to the mall was 4 percent on a base of $1,000,000, the rating would be based on the ratio

	Relocation	Storefront Renovation	Building Cleaning	Total
Store (or building) type				
Name of typical store (or building) type				
Frontage for typical store (or building)				
Cost for typical store (or building)				
Total frontage and/or number of stores (or buildings) in group				
Total costs for group				
Store (or building) type				
Name of typical store (or building)				
Frontage for typical store (or building)				
Cost for typical store (or building)				
Total frontage and/or number of stores (or buildings) in group				
Total costs for group				

Figure A-22. Relocation and renovation cost worksheet.

$\dfrac{10{,}000 + 40{,}000}{1{,}000{,}000 \times 4\%} = \dfrac{50{,}000}{40{,}000} = 1.25$. From the scale, the score must be interpolated between 0 and -2.5, and is -0.6. This is rounded to -1.

3.2.3 *Ease of Deliveries and Employee Commuting*

A significant purpose of a shopping mall or commercial district is to increase the flow of merchandise into and out of the area; hence, the ease of deliveries to an area is important. The flow of goods out of the area is usually handled by the pedestrians, particularly in downtown locations.

There are three major methods of truck deliveries to downtown businesses and other freight receivers. One is via off-street loading docks; another is on-street curb parking immediately adjacent to a rear door or side door to the store or building; and the third is on-street curb deliveries using the front customer entrance. Each of these will be affected differently by motor vehicle traffic restrictions.

Off-street loading docks can be found at very large freight attractors such as large department stores, hotels, and office buildings. They are preferable to other forms of goods delivery because conflicts between trucks and pedestrians or other motor vehicles are greatly reduced or eliminated. Therefore, if the facilities affected by motor vehicle restrictions have off-street loading bays, they will not be impacted by the restrictions (unless they apply to the street on which the approach to the loading dock is located) and thus they score a 0 (for no gain or loss). If the addition of off-street loading areas is included as part of a new building under construction concurrently with the pedestrian facility, it would merit +10 because it is a big improvement. On the other hand, if an off-street loading dock were required to be added to an existing building that does not now have one, it should score -10 because of the much greater expense of retrofitting, when compared with building the facility into the building from the beginning.

If there is now on-street curb parking, there may be priority parking for trucks, no special provision for truck parking, or illegal truck parking and standing. If curb deliveries will still be permitted, and the parking regulations remain the same, score 0 because there is no gain or loss, unless there is significant interference with sidewalk pedestrian traffic. If parking regulations are changed to make deliveries easier, score +5. An example of this regulation would be establishment of a truck loading zone with commercial vehicle parking only between 7 a.m. and 7 p.m. Similarly, score -5 if parking regulations and access are changed in a manner that makes deliveries significantly more difficult.

If motor vehicle traffic is prohibited during all or part of the day on a street, stores that receive their deliveries on that street will have to make other arrangements. Deliveries may be permitted only during certain hours of the day, depending on local conditions—store hours, office hours, and peak-hour congestion. This might require certain adjustments on the part of receivers and the trucking companies due to labor contracts and security considerations. However, over the long run, adjustment may be more efficient because there would be no vehicle congestion to compete with delivery trucks, and store personnel could be organized to receive goods for a few specified hours per day. Smaller stores are affected by changes in the hours of deliveries more than larger stores, inasmuch as the person needed to receive the goods represents a significant fraction of the labor force for a small store. The score for this situation might range from +2, reflecting more efficient deliveries, as described in the foregoing, to −8 if there were a major inconvenience and significant cost for most truckers and receivers.

Truckers are likely to benefit from changes in the hours of deliveries at the expense of the receivers. Also, as previously noted, different stores will be affected differently by changes in regulations. If this is the case, a table should be constructed which shows the benefits or disbenefits to each stakeholder on a scale from +10 to −10. These should be combined, using appropriate weights, to arrive at an aggregate score. For example, consider a simplified situation with two stores and a trucking firm that serves both of them. If the big department store benefits slightly from the change of delivery hours (+2), the small shop is severely inconvenienced (−8), and the trucking firm benefits (+6), the net score would be zero if all three were weighted equally. If the small shop were given more weight, the net result would be a disbenefit, whereas if the trucker or the large store were weighted more highly, the net result would be a positive benefit.

An alternative to restricting truck traffic to certain hours is to prohibit it at all times, in which case the drivers would have to park on the nearest street and transport the goods to the store by hand or with a dolly. This could be a significant problem if there are heavy, bulky, or frequent deliveries. Trucks would usually be parked out of the view of the driver, so they might have to be locked where they were not previously. A special case is currency shipments to and from banks by armored car. If the courier must walk with money any distance away from his truck, there is a company rule that he must walk with his gun drawn. This will detract from the atmosphere of the mall, so it is suggested that armored cars be exempted from restrictions that apply to other trucks. This has been done on the Sparks Street Mall.

The score for an outright prohibition of trucks, requiring truck drivers or receivers to use handcarts for goods to be delivered to stores, will range from −5 to −10, depending on the distances involved, frequency, and nature of deliveries. An alternative to accommodate outright prohibition of trucks would be establishment of local consolidated delivery centers that would receive shipments for all affected buildings, and deliver the goods manually or mechanically (such as an underground conveyor belt system) to the ultimate receivers. Colorful carts could be used on the mall, and goods could be stored up to a day or two at the central facility, so the actual deliveries could be made at a time most convenient to the shop owners, taking into account pedestrian traffic volumes. Once this facility were established, it could prove to be a net benefit, perhaps with a score of +5, depending on its operating costs and success.

It is not expected that a pedestrian facility will cause inconvenience to employees who commute to the site, because pedestrian access will be improved. For some employers, however, lack of parking or other inconveniences might cause difficulty in attracting and retaining employees. If this is the case, subtract up to 5 points from the ease of delivery score to reflect any special problems for employee commuters. Figure A-23 recapitulates the suggested scoring for this item.

3.2.4 Attractiveness of Area to Business

Check off the proper boxes in the following:

	YES	NO
Is there a significant rise in the rate of voluntary improvements to the property?	2	0
Is there a trend toward the acquisition of additional selling and storage space?	2	0
Is there a low vacancy rate for stores?	2	0
Is there expressed interest by out-of-town firms to move into the area of the pedestrian facility? (This may be measured by the volume of inquiries to the Chamber of Commerce or the local economic development administration if there is one.)	2	0
In addition to advertising for individual stores, do the merchants publicize the area surrounding the pedestrian facility as a place to go to shop?	2	0
Do the merchants show enthusiasm for the area as a place to do business?	2	0
Are there informative, educational, or entertaining displays in store windows or in hotel and office lobbies?	2	0
Are there any special promotional activities sponsored, such as car displays, boat shows, or sidewalk sales?	2	0
Is there a festive atmosphere, making the area pleasant for shopping?	2	0
Can many out-of-towners be found among the consumer foot traffic?	2	0

Total ATTRACTIVENESS TO BUSINESS SCORE is sum of values checked above

= ________ - 10 = ________.

4. GOVERNMENT AND INSTITUTIONS

4.1 Transportation and Land-Use Planning Process

4.1.1 Public Participation in the Planning Process

Societal attitudes and recent legislation have changed the role of the planner from one who works in relative isolation from the public as a whole, except perhaps for vocal private interest groups, to one who must solicit and obtain public input on current transportation projects that are in the planning and design phase (Yukubousky, 1974).

The public has become to a large extent wary, if not downright skeptical, of public decisions made in closed sessions outside of wide public discussion and has in effect "demanded" more voice in those decisions. This wariness is based on a confluence of three central emerging factors:

	Possible Score	Actual Score (leave blank if not applicable)
Facilities have off-street loading arrangements	0	
Off-street loading areas are to be added:		
For new construction	+10	
For existing buildings	-10	
Parking regulations:		
Remain the same	0	
Changed to make deliveries easier	+5	
Changed and make deliveries more difficult	-5	
Restriction of truck deliveries to certain hours	+2 to -8	
Outright prohibition of trucks	-5 to -10	
Above, but with local consolidated delivery centers	-5 to +5	
Inconvenience to employee commuters	0 to -5	

Total DELIVERIES AND COMMUTING SCORE is sum of values scored above = ________.

If sum of values exceeds +10, score +10.

If sum of values is less than -10, score -10.

Figure A-23. Urban goods movement point allocation.

• The emerging recognition by minority groups of their potential political power through organization and outspoken advocacy for minority-related issues.

• The recognition of a widespread abuse of public decision-making power for the benefit of a privileged few.

• The importance of the environmental protection movement as reflected in a wide variety of special-interest organizations.

If one accepts these precepts, the inclusion of public participation in public decisions is seen not so much as an inherent "good," but as essentially a political necessity. For example, it is entirely feasible that a public decision-making body could make decisions that had overwhelming public support without holding extensive public meetings and hearings. The degree of this public support has typically been based on "voting" records for funding specific proposals, and of course, for election of public officials. Over the past several years, the voting has more and more frequently rejected proposed bonding proposals and as a consequence has "forced" widespread public participation in the planning process as a practical necessity for their successful passage.

The current planning situation effectively requires a deliberate process for extensive public participation, and as a consequence of that realization we have provided a criterion to predict "in advance" the probable adequacy of that participation. In situations where comparisons of alternative pedestrian facilities for one site are under consideration, presumably the same planning process would apply to all, and this variable would then be logically dropped. Where different planning processes were in effect in different locations of a jurisdiction (for example, where local option determined the planning process), this variable would rate the most extensive public participation an inherent "good" and accordingly place it higher on the rating scale.

Figure A-24, adapted from Yukubousky (1974), describes a wide variety of community interaction techniques ranging from zero public participation to a high degree of community input. Some of the techniques that might involve the public to a major degree might, at first, seem inappropriate for simple pedestrian facilities, having been designed for preparation of comprehensive metropolitan and regional transportation plans. However, broad community participation is felt to be important for small projects also; therefore, the scale described in Figure A-24 is equally applicable to both small and large projects.

Because the primary purpose of the methodology described herein is evaluation, excluded from the discussion is an analysis of the significant roadblocks to achieving genuine levels of participation and increased input. For a holder of political power, these include paternalism and

Actions of Implementing Agency	Point Score
Monitor newspapers, radio, and television	-10
Conduct background studies and review election issues	-9
Catalog planning and design concepts	-8
Monitor impacts of complicated projects	-7
Initiate legislation	-6
Produce material for the media	-5
Present range of alternatives to public	-4
Map socioeconomic and attitudinal data	-3
Illustrate plans in nontechnical terminology	-2
Educate public about ongoing planning and decision-making process	-1
Maintain open planning and project files; listen to the public for suggestions	0
Survey opinions and attitudes	+1
Hold public hearings early in the planning process, with widespread publicity at least one month in advance of each meeting	+2
Hold a citizen referendum, to ensure draft plans will incorporate the majority opinion of the community	+3
Assemble a panel of community residents assisted by planners to make recommendations on alternative proposals at community meetings	+4
Set up community-led seminars	+5
Use a citizen advisory committee. Request a written review of all draft plans and alternative suggestions	+6
Mediate between parties	+7
Appoint a task force	+8
Hold workshops or informal neighborhood work meetings	+9
Employ community residents for brainstorming sessions, ombudsmen, and role playing	+10

PUBLIC PARTICIPATION SCORE selected = __________.

Figure A-24. Rating score for community interaction techniques.

resistance to power redistribution. On the public side, they include inadequacies of the political socioeconomic infrastructure and knowledge base plus extremes of self interest that do not allow proper consideration of the rights or needs of others. For further discussions of public participation in the planning process, the reader is directed to Yukubousky (1974), Manheim et al. (1975), Grigsby and Campbell (1972), and Fitzpatrick and Miller (1973).

4.1.2 Conformance with Requirements and Regulations

On the whole, it is judged to be advantageous if a proposed project can be implemented within existing local, state, and national laws and regulations without the requirement for a waiver or variance. Of course, inclusion of this variable weights the judgment in favor of the existing state of affairs and will thus make needed change all the more difficult. The rationale for its inclusion is to urge the planning process to make deliberate efforts to adhere to existing codes, regulations, and master plans, and thus avoid inclusion of unproved materials or design criteria unless they are deemed so desirable or necessary as to warrant the costly and timely process of seeking variances, the updating of codes and regulations, or the change to master plans.

Building code revisions are periodically presented to city councils, based on recommendations of the International Conference of Building Officials (or the Southern or Western Conference). They are adopted by most local jurisdictions with some amendments for local conditions and are available from most city halls. The city engineer or appropriate building inspector should be able to judge if a particular facility design is in compliance with existing codes.

Zoning ordinances are periodically assembled by local planning departments and forwarded to the planning commissions and city councils. There ordinances are on file with zoning maps and are accessible to the public. A member of the City Planning Department should be able to judge if a specific pedestrian facility complies with the local zoning ordinance. A facility will either comply or not; however, if it does not meet the regulations, a variance might be obtained following application for a waiver to the planning commission. Another possibility is that changes may be made to the regulations as a result of the review process for the pedestrian facility and then the modified regulations would apply to future projects, including those that are not pedestrian accommodations. For example, to create a charming atmosphere on Sparks Street, all hanging signs were required to be replaced by backlighted signs at the time a permanent mall was constructed. It was found that the backlighted signs improved the street so much that later an ordinance was passed stipulating that all new signs anywhere in Ottawa could not be of the hanging variety. This is an example of an indirect benefit attributable to the mall. In other cases, modifications made to building codes or zoning ordinances because of a particular pedestrian facility could be a benefit or a disbenefit, depending on the particular situation.

Assign a score between −10 and +10 to this variable. The following suggested values provide guidelines for the assignment:

- +10 Original or desired design of facility conforms to all requirements, codes, and regulations; no modifications required.
- +7 Minor changes to facility or variance to regulations required.
- 0 Some changes to facility design or regulations, or both, indicated.
- −7 Modifications to facility design required, resulting in delay of implementation.
- −10 Extensive modifications of planned or desired facility design required, resulting in much delay.

REQUIREMENTS AND REGULATIONS SCORE selected = ______.

4.2 Economic Impacts

4.2.1 Net Change in Tax Receipts and Other Revenue

Changes in government revenues can be estimated in dollars by the planner with inputs from appropriate government agencies.

Sales taxes are usually collected by the state and partially reimbursed to the cities (or sometimes *vice versa*), thus gross receipts data are available from the collection agency. Data are categorized by the state of sale and are considered confidential, but they should be available on an aggregate basis, either for geographic units or by type of business.

Corporate income statistics can be obtained from the state or federal revenue collection agencies on a countywide basis, which covers too wide an area for our purpose. However, geocoding programs of 1970 census data in some states have made it possible to measure data by city cells. These data are confidential, under the control and security restraints of the government, but are accessible on a contractual basis.

Change in assessed property valuation, and hence property tax revenues, may be estimated by the assessment office of the city or county government. If this total change is X percent, it is assumed that it occurs at a rate of $X\%/5$ for the first 5 years and then remains at the resulting level for the next 20 years, making a total planning horizon of 25 years. According to data collected by the Downtown Research and Development Center (1975) for Kalamazoo, Mich., Knoxville, Tenn., and Pomona, Calif., X can range from 20 percent to 75 percent.

The change in revenue from pedestrian moving violation fines may be determined by consultation with the appropriate judicial system.

If the pedestrian facility were strictly a business investment on the part of a municipal government, this variable would be the most important evaluation criterion. However, other motivations (i.e., the other variables) are likely to be more significant. Further, tax receipts and other government revenue resulting from a particular pedestrian facility will be mixed with other general revenue, not specifically earmarked to defray the facility's operating and construction costs. Thus, the magnitude of additional revenue can be compared with the government's total budget rather than merely with the expenditures for the pedestrian facility. For a small city within a metropolitan area, a major new shopping/commercial pedestrian facility might generate municipal revenue as much as 10 percent of the city budget, although in most cases it will be a smaller fraction. Ten percent is used to set the endpoint of the scale for this variable.

To evaluate this variable, estimate as accurately as possible the average annual change in sales, corporation income and property tax receipts; parking, motor vehicle, and pedestrian violation fines; and other government revenue attributable to the pedestrian facility for the first two years. The annual average over a two-year period is taken to compensate for the first year's settling-in period, as is done for retail sales in Section 3.2.1. Divide this annual change by the total city budget, exclusive of the pedestrian facility. When expressed as a percentage, the number will be equal to the rating for this variable. Because +10 is the maximum scale value, indicate as +10 any increase in revenue of more than 10 percent. If a decline in total municipal revenues is greater than 10 percent, discussions should be held to examine alternatives with less serious revenue impacts.

TAX RECEIPTS SCORE selected = ______.

4.2.2 Resulting Changes in Employment

This variable may be determined directly upon examination from the specifications for the pedestrian separation facility and discussions with affected business persons. There will probably be no major losses of employment due to a pedestrian facility. School crossing guards are perhaps the group that will be affected the most; if a facility were to result in a major loss of sales positions, it would not have been constructed in the first place. However, a major shopping mall or auto-free zone could result in a significant rise in the number of sales personnel. The following scoring scale takes these facts into account:

Decrease in Employment		Increase in Employment	
Number of Jobs Lost	Point Score	Number of Jobs Gained	Point Score
10	−10	100	+10
8	−8	80	+8
6	−6	60	+6
4	−4	40	+4
2	−2	20	+2
0	−0	0	0

EMPLOYMENT SCORE is value selected = _______.

4.2.3 Change in the Cost of Providing Community Services

This category covers all activities performed by local governing units. Revenue sources and expenditures may reflect a variety of categories, such as police and fire protection, transit, street maintenance and cleaning, beautification of adjacent areas, and lighting. In most locales, the budgets are divided along program lines. Present costs can be extracted from municipal budgets with the help of the city budget office, and cost projections can also be made with their help.

Express the increase or decrease in cost of providing community services as a signed percentage fraction of the present cost for providing these services citywide. This fraction (which will ordinarily be less than 10 percent) is equal to the rating for this variable after reversing the signs to indicate desired direction. If the fractional change in cost of providing community services for the entire political jurisdiction increases more than 10 percent, indicate the score at −10. If costs decrease by greater than 10 percent, indicate the score as +10.

COMMUNITY SERVICES SCORE selected = ______.

4.3 Community Impacts

4.3.1 Community Activities

The demand for community activities such as displays, exhibits, special events, recreation, arts and crafts festivals, and fund-raising drives can serve as an indicator of the attractiveness of the area and city in which the pedestrian facility is located. An increase or decrease in the number of such activities will show changes in public participation in the community. Although permits are the source for monitoring this type of activity, they are necessary only if the event occurs on city property or if a street closure or sidewalk obstruction is required. Many of these events take place on private property and do not require official sanction. Peddlers, solicitors, and auction licensing may be another source of monitoring.

Records of community activities are available from local police departments and licensing departments. However, files are not longstanding and are frequently destroyed on expiration dates or immediately thereafter. Forecasting the change in such activities is an extremely subjective undertaking unless representatives of community groups that sponsor the activities have been involved in the planning process.

Indicate the score for change in community activities on the following scale:

-10	0	+10
Large decrease in community activities	No change in community activities	Large increase in community activities

COMMUNITY ACTIVITIES SCORE selected = __________.

4.3.2 Adaptability to Future Urban Development Plans

The adaptability of the pedestrian facility (as a transportation link) to future transportation system development plans is covered in Section 1.3.1. However, many facilities, particularly those designed for the purpose of providing a safe and enjoyable place for pedestrians to move leisurely and stop, impact the land uses in the vicinity as much or more than they affect the transportation system. The degree to which the facility fosters or hinders planned land uses for the area is measured by this variable.

As an example, consider a downtown pedestrian mall. Although a pedestrian mall may introduce a revitalization to a downtown area, alone it might be insufficient to save a city that has already gone into decay. If businesses will be moving out of the area with no replacement, there will not be any pedestrians left to enjoy the mall.

Evaluation of the impact of the facility on planned development can be performed best by an urban planner responsible for the area in question. Indeed, if the facility has been proposed by the planning or development agency having jurisdiction over the area, there is assurance that the facility's operation will conform with long-term development plans for the area. Unless there is in-house struggling, the score for this situation would be +10. For other conditions, the rating should be assigned accordingly.

-10	-5	0	+5	+10
Requires significant modifications to existing land use and development to accommodate the facility		No significant effect on short- or long-term land use and development plans		Enhances desired land use and growth patterns

FUTURE URBAN PLANS SCORE selected = _________.

4.3.3 Construction Period

The complete evaluation methodology could be used for assessing the impacts of the construction period in the same way that the over-all project is evaluated. However, this would be needlessly time-consuming, unless the decision-maker were to attach an extremely high importance to this one factor. Hence, the following simplified procedure is proposed as an alternative to using the entire methodology for evaluating construction period impacts.

Check off the applicable boxes in Figure A-25. The first five items compare the impacts of the construction process on pedestrians, vehicles, and businesses with the situation immediately prior to the commencement of construction. The sixth item has to do with the noise level of the construction process. The final item (Figure A-26), concerning the length of the construction period, is weighted more highly than the others inasmuch as this affects the duration of all of the impacts.

	Compared with Existing Situation, Construction is:				
Effects of Construction On:	Much Worse	Slightly Worse	The Same	Slightly Better	Much Better
1. Pedestrian movement	-1	-1/2	0	1/2	1
2. Vehicle movement	-1	-1/2	0	1/2	1
3. Safety	-1	-1/2	0	1/2	1
4. Pedestrian environment	-1	-1/2	0	1/2	1
5. Local business	-1	-1/2	0	1/2	1

Effects Score is sum of values in boxes checked = ___________.

6. What is the level of regularly occurring construction noises?

None or less than 65 db(A)	1
65 to 77.5 db(A)	0
Louder than 77.5 db(A)	-1

NOISE SCORE selected = ____________.

Figure A-25. Construction effects scoring.

What is the length of time of the construction period?

Less than one month	4
1-2 months	3
2-3 months	2
3-4 months	1
4-5 months	0
5-7 months	-1
7-9 months	-2
9-11 months	-3
One year or longer	-4

Duration Score selected = __________

Total CONSTRUCTION SCORE is

Effects Score + Noise Score + Duration Score = _______.

Figure A-26. Construction duration scoring.

APPENDIX B

CASE STUDY REPORTS

TESTING OF DEVELOPED TECHNIQUES

To ensure that the methodology could be applied to real-life situations, the research plan called for testing the developed techniques at both existing and proposed pedestrian-vehicle separation facilities. Contacts were made early in the study with planners who were proposing pedestrian facilities: the purpose was to share preliminary plans and findings. After a first draft of the measurement techniques had been prepared, field trips were made to four sites in order to apply the techniques. Observations during these field trips were used to make substantial modifications to the measurement techniques.

Two planned and two existing pedestrian facilities were selected for testing of the evaluation methodology. The specific sites represent widely different types of facilities, as follows:

- A pedestrian overpass under construction at Rainier Avenue S. and Empire Way S. in Seattle, Wash.
- 20th Avenue N.E./Ravenna Park Bridge (Seattle) closure to motor vehicles.
- Sparks Street Mall, Ottawa, Ont.
- Proposed Fulton Mall, Brooklyn, N.Y.

Rainier Avenue and Empire Way (Fig. B-1) are major arterials in Seattle, and their intersection is a particularly hazardous one for pedestrians. After more than five years of study, construction of a $600,000 overpass crossing both streets began in the summer of 1975. Because only minor construction activity had started during the time of the evaluation, Rainier and Empire was treated as the location for a "planned" facility.

The 20th Avenue N.E. Bridge over Ravenna Park in Seattle was closed to motor vehicles beginning March 11, 1975 as a demonstration project to evaluate its impact on traffic patterns and the surrounding community. The trial period ended in August 1975, at which time a decision was made to continue with the closure and replace the temporary barriers with more permanent ones. It is good policy to wait several years before testing an existing facility to allow for settling-in effects, but the shorter period seemed justified in this case because the impacts of the bridge closure are very localized, and they are not continuing to change. The bridge is shown in Figure B-2.

Sparks Street Mall in Ottawa (Fig. B-3) is a success by any evaluation criteria. It has many amenities, is a very pleasant environment, and is crowded with pedestrians in the daytime. Property values on Sparks Street have tripled

Figure B-1. Intersection of Rainier Avenue and Empire Way, Seattle, Wash., site of planned pedestrian overpass.

Figure B-2. Closure of 20th Avenue N.E./Ravenna Park Bridge to vehicular traffic, Seattle, Wash.

Figure B-3. Sparks Street Mall, Ottawa, Ont.

in the last ten years. The mall was first planned in 1959, and was experimented with as a temporary summer mall every year from 1960 through 1965, when it became a permanent street closure. The permanent mall was completed in 1967.

Fulton Street is the focus of retail activity in downtown Brooklyn, N.Y., attracting 200,000 shoppers each day. Figure B-4 shows Fulton Street as it is today. The Fulton Mall has been proposed as a pedestrian transitway to speed up pedestrian and bus flow (60 buses during the peak hour) by eliminating vehicle conflicts. Adjacent streets are sufficient to handle diverted traffic and sufficient off-street parking is available to replace the parking eliminated on the side streets approaching Fulton Street. The novel attraction of the Fulton Street closure, however, is the installation of a teflon-coated fiberglass canopy above the street. In addition to protecting pedestrians from direct overhead precipitation, the arcade has symbolic significance in showing the city's commitment to downtown Brooklyn and the rejuvenation of an already very busy shopping area. Figure B-5 shows an artist's concept of the proposed arcade.

The sites selected for testing range in complexity from the 20th Avenue N.E. bridge and the Rainier and Empire overpass, which are relatively simple facilities, to the Fulton Mall and the Sparks Street Mall. The diversity of these facilities is an important reason for selecting them as examples. Another reason was that the local planners were actively involved with their specific facilities and eager to work with the researchers.

The following sections describe the results of these field

Figure B-4. Fulton Street, Brooklyn, N.Y., site of planned pedestrian mall.

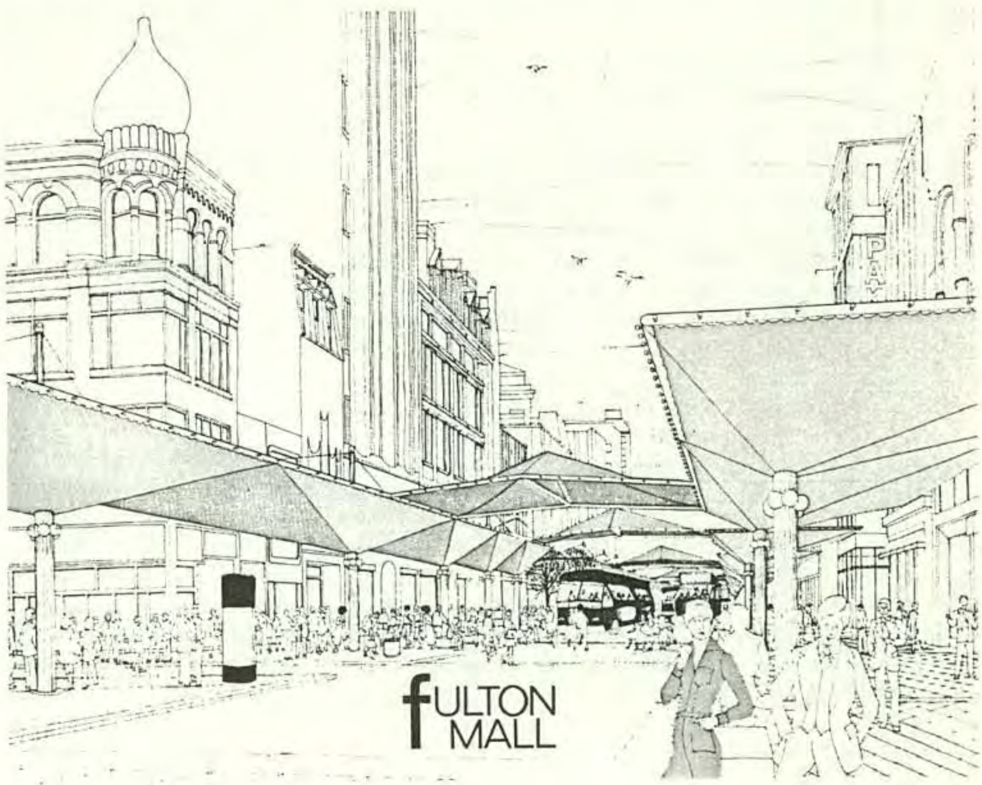


Figure B-5. Proposed Fulton Mall (see Fig. 4).

evaluations. For each facility, the score for each variable (and its components, if any) is provided, as well as a discussion of how the score was derived, and any other pertinent comments. A summary sheet has been completed for each facility, and these follow their respective sections.

RAINIER AVENUE S. AND EMPIRE WAY S. OVERPASS

This is a very hazardous intersection for pedestrians. Two major arterials converge at an oblique intersection close to a high school and several fast food outlets. The pedestrian signal across Empire Way is much too short for the 120-ft (36.6 m) crossing (see Fig. B-6). Indeed, the hapless pedestrian must begin to walk quickly (4 mph, 18 m/sec) at the very moment the light becomes green. There is also a conflict with turning vehicles at each pedestrian crossing, as also shown in Figure B-6.

The evaluation of this facility is described for each of the following variables, followed by a completed summary sheet.

1.1 Pedestrian Transportation

1.1.1 Travel Time

The proposed facility will result in significant travel time savings for pedestrians. Average route length will be reduced, and two delays at intersections will be avoided. Combining these fatcors yielded a travel time ratio before and after the facility of 1.0 to 0.4, respectively, for the crossing.

$$\text{TRAVEL TIME SCORE} = \frac{1.0 - 0.4}{1.0} \times 10 = +6$$

1.1.2 Ease of Walking

EASE OF WALKING SCORE = 2, the sum of the components listed below:

1.1.2.1 Walking Surface. Walking surface score = 1.

1.1.2.2 Grade Changes. The west ramp of the overpass rises 15 ft (4.6 m) over a distance of approximately 72 ft (22 m), almost 21 percent. The east ramp rises 16 ft (4.9 m) over a distance of approximately 71 ft (21.7 m), or 22.5 percent. The change in grade from the lowest point to the highest point is 20.9 ft (6.4 m). Grade score = $-1.7 + .2 = -1.5$.

1.1.2.3 Continuity. Continuity score = 2 − 1 = 1.

1.1.2.4 Signing. Signing score = 1.

1.1.2.5 Lighting. The overpass will have ornamental pedestrian-oriented lighting. Lighting score = 0.

1.1.3 Convenience

The overpass will be open at all hours and will provide access to bus stops, parking, Franklin High School, several fast-food outlets, and a residential neighborhood.

CONVENIENCE SCORE = 5

1.1.4 Special Provisions

The overpass will have handrails, and is safe for blind pedestrians. However, there are no special provisions for bicyclists or joggers, there are no telephones or drinking fountains, and traversing the facility requires the pedestrian to climb up and down 20 ft (6.1 m).

SPECIAL PROVISIONS SCORE = 0

1.2 Motor Vehicle Transportation

1.2.1 Vehicle Travel Costs

There is no significant change in motor vehicle travel costs or travel time with the overpass because they must still stop to allow opposing traffic to cross. Whereas previously during the red signal vehicles and pedestrians could cross, after the overpass is completed only vehicles will cross, but the signal cycle will still be the same. There will be no changes in parking supply or in vehicle ownership.

VEHICLE TRAVEL COSTS SCORE = 0

1.2.2 Use of Automobiles

USE OF AUTOMOBILES SCORE = 0

1.2.3 Signal/Signing Needs

Signs will be needed to direct pedestrians to the overpass and instruct them to no longer use the previous crossings.

SIGNAL/SIGNING NEEDS SCORE = 7

1.3 Other Community Transportation

1.3.1 Future Transportation Plans

The overpass does not affect any future transportation plans. Its height is sufficient for any future highway designations of either Rainier Avenue or Empire Way.

FUTURE TRANSPORTATION PLANS SCORE = 0

1.3.2 Existing transportation

Concurrent with construction of the overpass, bus stops will be slightly relocated into new indented curb bays, but this will have no significant impact on transit operations or use.

EXISTING TANSPORTATION SCORE = 0

2.1 Safety

2.1.1 Cost of Accidents

Because complete separation of pedestrians and vehicles is intended by this facility, the maximum benefit value would be expected. However, in spite of planned hedges to prevent pedestrian crossing at the street level, all such crossings probably will not be prevented and an 80 percent effectiveness factor is estimated. Note (see Appendix A) that this value could be scaled downward if comparison were being made among several different locations including some with greater accident risk.

COST OF ACCIDENTS SCORE = +8

2.1.2 Accident Threat

This variable does receive maximum points for complete separation of pedestrians and vehicles, and thereby reflects

the point of view that at-grade crossers ignore the threat of accident.
ACCIDENT THREAT SCORE = +10

2.1.3 Crime Concern

Except for possible vandalism, this variable does not apply.
CRIME CONCERN SCORE = −2

2.1.4 Emergency Access/Medical and Fire Facilities

This variable does not apply.
EMERGENCY SCORE = 0

2.2 Attractiveness of Surroundings

2.2.1 Pedestrian-Oriented Environment

The only amenities are the plants and trees that will be planted to block the previous pedestrian crossing. These

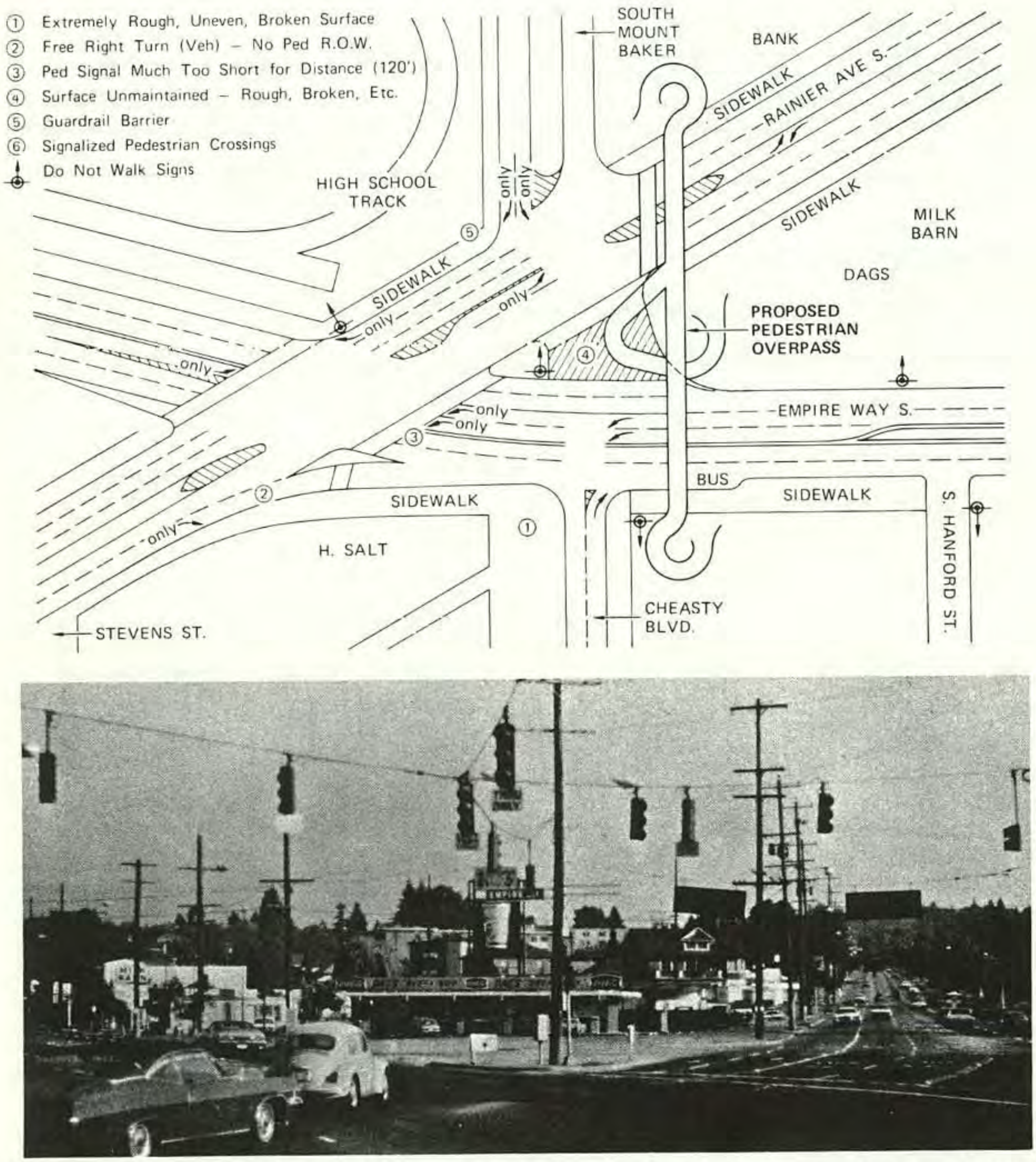


Figure B-6. Location of proposed Rainier and Empire pedestrian overpass (upper) with cars turning left into Rainier Avenue from Empire Way (lower).

are offset by the large signs advertising local fast-food outlets and the concentration of motor vehicle odors at the level of the overpass.

PEDESTRIAN-ORIENTED ENVIRONMENT SCORE = −6

2.2.2 *Litter Control*

The sidewalks are moderately clean of litter, and trash baskets are sufficiently placed.

LITTER CONTROL SCORE = 4

2.2.3 *Density*

The overpass will have slightly more than 2,000 sq ft (190 m^2). During most of the day, no more than two or three persons will use the facility at any one time, but on school days as many as 20 students might use the overpass simultaneously to travel to or from Franklin High School. Thus, peak and off-peak density might be 100 sq ft (9.3 m^2) and 700 sq ft (6.5 m^2) per person, respectively.

DENSITY SCORE = 8

2.2.4 *Climate Control and Weather Protection*

The overpass offers pedestrians no protection from the environment.

CLIMATE AND WEATHER SCORE = −10

2.3 Environment/Health

2.3.1 *Air Pollution*

Air pollution is essentially unaffected by this facility.

AIR POLLUTION SCORE = 0

2.3.2 *Noise Impacts*

Estimated noise level at 20 ft above the roadway traffic is about 68 db(A).

NOISE SCORE = −10 [(90 − 68) × 0.4] = 1.2, which is rounded to −1.

2.3.3 *Health Effects*

Negative health effects are due primarily to the presence of high volumes of vehicle traffic close to the pedestrians.

HEALTH SCORE = −3

2.3.4 *Conservation of Resources*

Very low use of direct energy and low maintenance requirements during operation make this facility basically conservative in its use of resources.

CONSERVATION SCORE = +7

3.1 Residential Neighborhoods

3.1.1 *Residential Dislocation*

No residences will be displaced by the overpass.

RESIDENTIAL DISLOCATION SCORE = 0

3.1.2 *Community Pride and Interaction*

There is only a minor impact on the community.

COMMUNITY PRIDE AND INTERACTION SCORE = 0

3.1.3 *Aesthetic Impact, Compatibility with Neighborhood*

Positive compatibility components are continuity of pathway and complementary lighting. The single negative compatibility characteristic is the possibility of additional litter or vandalism.

AESTHETICS AND COMPATIBILITY SCORE = +1

3.2 Commercial/Industrial Districts

3.2.1 *Gross Retail Sales*

The overpass may increase sales at Dag's Hamburger Stand, which is located immediately adjacent to the center stairway, but this effect will be minimal, because almost all of Dag's current customers arrive by automobile.

RETAIL SALES SCORE selected = +1

3.2.2 *Displacement or Renovation*

No businesses have been displaced, but small parcels of land have been purchased at opposite sides of Rainier Avenue to accommodate bus bays at the new bus stop locations. The proprietors of Dag's refused to sell their land, because they were concerned that the overpass would obstruct the view of their sign. Several years ago, they purchased a lot and building that was then very near the location of the overpass, and demolished it, so passing motorists could get a better view of their sign. The purchase price of $44,000 is a proxy measure of the value to Dag's of an unobstructed sign. Assuming current sales of $1,000 per day, a 1 percent increase in sales would gross only an additional $3,650 annually. $44,000 is more than twelve times that amount, so from the scale given for this variable in Appendix A, read a point score of −10.

DISPLACEMENT OR RENOVATION SCORE selected = −10

3.2.3. *Ease of Deliveries and Employee Commuting*

The overpass has no impact on either truck deliveries or employee commuting.

DELIVERIES AND COMMUTING SCORE = 0

3.3.4 *Attractiveness of Area to Business*

The intersection of Rainier Avenue S. and Empire Way S. does not possess any of the attributes of an attractive area to do business.

ATTRACTIVENESS TO BUSINESS SCORE = −10

4.1 Transportation and Land-Use Planning Process

4.1.1 *Public Participation in the Planning Process*

A formal public hearing on the proposed overpass was held before the Seattle City Council on March 15, 1971.

PUBLIC PARTICIPATION SCORE selected = +2

4.1.2 Conformance with Requirements and Regulations

The design for the overpass complies with all applicable requirements and regulations, including height clearances.
REQUIREMENTS AND REGULATIONS SCORE = +10

4.2 Economic Impacts

4.2.1 Change in Tax Receipts

The overpass will not cause any change to Seattle's tax receipts or other revenue.
TAX RECEIPTS SCORE = 0

4.2.2 Changes in Employment

EMPLOYMENT SCORE = 0

4.2.3 Cost of Providing Community Services

The only change in costs will be gardening for the plants and trees to be planted adjacent to the overpass. These additional costs are negligible, however, compared to Seattle's total maintenance budget.
COMMUNITY SERVICES SCORE selected = 0

4.3 Community Impacts

4.3.1 Community Activities

There will be no change in community activities as a result of the overpass.
COMMUNITY ACTIVITIES SCORE selected = 0

4.3.2 Adaptability to Future Urban Development Plans

The land-use and development impacts of this facility will be negligible at the location where it is being constructed.
FUTURE URBAN PLANS SCORE selected = 0

4.3.4 Construction Period

Construction of the overpass will hinder pedestrian and vehicle movement slightly. It enhances the pedestrian environment slightly, because the activities are interesting to watch. Construction will have no impact on safety or local businesses. Average level noises are expected. The construction contract, however, will last for more than one year.
CONSTRUCTION SCORE = $-\frac{1}{2} + 0 - 4 = 4\frac{1}{2}$ rounded to -5

Summary

Figure B-7 summarizes the evaluation variable scores for the proposed pedestrian overpass at Rainier Avenue S. and Empire Way S.

20TH AVENUE N.E./RAVENNA PARK BRIDGE

1.1 Pedestrian Transportation

1.1.1 Travel Time

The closure of this bridge to motor vehicles will have no effect on pedestrian travel time because no pedestrian-vehicle conflicts were eliminated. Traffic on the streets in the community adjacent to the bridge has been reduced, but the impact on pedestrian delay is minor because traffic was light to begin with. Also, these minor pedestrian delay savings are likely to be offset by corresponding increases in traffic to other through streets.
TRAVEL TIME SCORE = 0.

1.1.2 Ease of Walking

EASE OF WALKING SCORE = 3, based on summing the following five components.

1.1.2.1 The walking surface after the bridge closure remains the same as it was previously. Walking surface score = ½.

1.1.2.2 There are no grade changes for the pedestrian because the bridge takes him over a very steep ravine. Grade Change score = 2.

1.1.2.3 The pedestrian path across the bridge is straight and unhindered. Continuity score = 1.

1.1.2.4 Little signing exists now or is needed. Signing score = 1⅓.

1.1.2.5 There is no lighting on the bridge, although there are lights in the park below. Lighting score = —2.

1.1.3 Convenience

The bridge now provides an improved bicycle route; it serves the University of Washington and the surrounding residential area. The bridge is always open.
CONVENIENCE SCORE = 3

1.1.4 Special Provisions

Handicapped persons no longer have to negotiate a curb because they can use what was formerly the roadway. There are no telephones, drinking fountains, or special provisions for the blind or for joggers. Although it has not been designated as such, the curbs and white centerline could be used to delineate a bicycle path separate from that for pedestrians.
SPECIAL PROVISIONS SCORE = —1

1.2 Motor Vehicles

1.2.1 Vehicle Travel Costs

Approximately 3,000 vehicles per day were rerouted because of the bridge closure. This was well handled by the existing street network. Indeed, the level of service at one intersection approach (25th Ave. and N.E. 65th St., north approach) actually experienced an improved level of service (from C to B) during the A.M. peak period, whereas the level of service at all other intersection approaches remained the same. However, at the 25-mph speeds typical

Name of Project RAINIER AVENUE AND EMPIRE WAY

Cost initial $ 600,000 annual $ 100.00

+173 Total Score

			Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1	Travel Time	+6	2.5%	15
	1.1.2	Ease of Walking	+2	3.0	6
	1.1.3	Convenience	+5	3.5	18
	1.1.4	Special Provisions	0	2.5	0
1.2 Motor Vehicle Transportation	1.2.1	Vehicle Travel Costs	0	6.0	0
	1.2.2	Use of Automobiles	0	2.5	0
	1.2.3	Signal/Signing Needs	+7	2.0	14
1.3 Other Community Transportation	1.3.1	Future Transportation Plans	0	3.0	0
	1.3.2	Existing Transportation	0	3.0	0
2.1 Safety	2.1.1	Cost of Accidents	+8	12.0	96
	2.1.2	Accident Threat	+10	7.0	70
	2.1.3	Crime Concern	-2	3.0	-6
	2.1.4	Emergency	0	3.5	0
2.2 Attractiveness of Surroundings	2.2.1	Pedestrian Oriented Environment	-6	5.0	-30
	2.2.2	Litter Control	+4	1.0	4
	2.2.3	Density	+8	1.5	12
	2.2.4	Climate Control & Weather Protection	-10	1.5	-15
2.3 Environment/ Health	2.3.1	Air Pollution	0	3.0	0
	2.3.2	Noise	-1	1.5	-2
	2.3.3	Health	-3	1.5	-5
	2.3.4	Conservation	+7	1.5	11
3.1 Residential Neighborhoods	3.1.1	Residential Dislocation	0	2.0	0
	3.1.2	Community Pride & Interaction	0	3.5	0
	3.1.3	Aesthetics & Compatibility	+1	3.0	3
3.2 Commercial/ Industrial Districts	3.2.1	Retail Sales	+1	1.5	2
	3.2.2	Displacement or Renovation	-10	1.5	-15
	3.2.3	Deliveries & Commuting	0	2.0	0
	3.2.4	Attractiveness to Business	-10	2.5	-25
4.1 Planning Process	4.1.1	Public Participation	+2	2.5	5
	4.1.2	Requirements & Regulations	+10	2.0	20
4.2 Economic Impacts	4.2.1	Tax Receipts	0	1.5	0
	4.2.2	Employment	0	1.0	0
	4.2.3	Community Services	0	1.5	0
4.3 Community Impacts	4.3.1	Community Activities	0	2.5	0
	4.3.2	Future Urban Plans	0	2.0	0
	4.3.3	Construction	-5	1.0	-5

Figure B-7. Evaluation summary sheet for proposed pedestrian overpass at Rainier Avenue and Empire Way, Seattle. Wash.

of this primarily residential area, the change in operating costs and travel time at this one intersection is less than 1%. Because there is no change in any of the other intersection approaches, the over-all impact of the bridge closure on motor vehicle operating costs and travel time is negligible. There is no impact on automobile ownership or parking.

VEHICLE TRAVEL COSTS SCORE = 0

1.2.2 Use of Automobiles

The bridge closure will have no effect on automobile travel.

USE OF AUTOMOBILES SCORE = 0

1.2.3 Signal/Signing Needs

Signs were needed (and were installed) at a number of locations on 20th Avenue N.E. to warn motorists that it is no longer a through street.

SIGNAL/SIGNING NEEDS SCORE = −5

1.3 Other Community Transportation

1.3.1 Future Transportation Plans

According to the city's evaluation of the experimental closure (van Gelder, 1975),

> The City's Comprehensive Bikeway Plan indicates 20th Avenue N.E. as a possible bikeway corridor. The increase in the number of bicycles indicates a substantial usage of 20th Avenue N.E. as a north-south route for cyclists and supports the current Comprehensive Plan.

FUTURE TRANSPORTATION PLANS SCORE = 5

1.3.2 Existing Transportation

Bicycle use of the bridge increased by approximately 20 percent after it was closed to motor vehicles.

EXISTING TRANSPORTATION SCORE = 5

2.1 Safety

2.1.1 Societal Cost of Accidents

Very few pedestrian/vehicle conflicts occurred in the vicinity of the bridge before closure so a "does not apply" score of 0 is appropriate (this variable measures change in accident costs).

COST OF ACCIDENTS SCORE = 0

2.1.2 Accident Threat

All vehicle conflicts have been eliminated for pedestrians, so the maximum score is assigned. The positive value when all conflict is eliminated reflects unrestricted use of the facility by pedestrians without fear of accidents.

ACCIDENT THREAT SCORE = +10

2.1.3 Crime Concern

Numerous positive features that alleviate crime concern (openness, long line of sight, community awareness programs, very few idlers, and cleanliness) are offset by important negative features such as infrequent police patrols, few fellow pedestrians, and no communication devices.

CRIME CONCERN SCORE = −1

2.1.4. Emergency Access/Medical and Fire Facilities

Access to emergency vehicles only is provided across the bridge. This is partially offset, however, by lack of communication facilities and the scarcity of fellow pedestrians in case of emergency.

EMERGENCY SCORE = +2

2.2 Attractiveness of Surroundings

2.2.1 Pedestrian-Oriented Environment

The positive impacts are Ravenna Park, complete with trees, gardens, birds, a stream, and picnic tables. The single negative impact is the existence of overhead utility wires.

PEDESTRIAN ENVIRONMENT SCORE = $(6 - 2 \times 1) \div 2 - 5 = -3$

2.2.2 Litter

20th Street N.E. is free of litter. However, this is offset by the fact that there are no litter baskets.

LITTER CONTROL SCORE = 0

2.2.3 Density

The bridge usually has no more than two or three pedestrians using it at any one time.

DENSITY SCORE = 6

2.2.4 Climate and Weather

There are no provisions for climate control or weather protection on the bridge.

CLIMATE AND WEATHER SCORE = 0

2.3 Environment/Health

2.3.1 Air Pollution

Similar to the situation for vehicle travel costs (1.2.1), the rerouted traffic does not significantly increase air pollution levels over the impact area because congestion does not increase. A local exchange does take place, however, because of eliminating vehicles in the vicinity of the bridge, and the lowering of traffic on 20th Avenue north of the bridge. This is offset by slight local increases on other streets.

AIR POLLUTION SCORE = 0

2.3.2 Noise Impacts

Peak-hour traffic before closure was about 6 veh per min, with an average of less than 1 veh per min over the rest of the day. Vehicle noise was low, but the old bridge structure was quite noisy. Present noise levels (with the closure) are below 50 db(A). Peak noise levels are caused by vehicles several blocks away, accelerating up an incline, and by overhead airplanes.

NOISE SCORE = $-10 + [(90 - 50) \times 0.4] = +6$

2.3.3 Health Effects

Elimination of vehicles; wide lane suitable for joggers, bicyclists, and pedestrians; low noise levels; and a pleasant natural environment all encourage healthful activity.
HEALTH SCORE $= +5$

2.3.4 Conservation of Resources

This facility is a good example of reuse of existing materials, with almost no new resources needed. In fact, a more expensive alternative considered was to remove the bridge; a still more expensive alternative was to widen and strengthen the structure.
CONSERVATION SCORE $= +10$

3.1 Residential Neighborhoods

3.1.1 Residential Dislocation

RESIDENTIAL DISLOCATION SCORE = 0

3.1.2 Community Pride and Interaction

The community showed its approval of the project in response to a survey. A reduction of through traffic will increase privacy, and the bridge makes a good bicycle or jogging path.
COMMUNITY PRIDE AND INTERACTION SCORE = 4

3.1.3 Aesthetics and Compatibility

The bridge closure scores well on all of the positive components, except for color. The utility wires detract from the view.
AESTHETICS AND COMPATIBILITY SCORE = 7

3.2.1 Commercial/Industrial Districts

There are five automobile service stations, a fast-food franchise, and a convenience store on 25th Avenue N.E. that might benefit from the 7 percent increase in traffic on 25th Avenue N.E. If the relationship of a 1 percent increase in retail sales for each 10 percent increase in pedestrian traffic can be extended for motor vehicle traffic passing convenience stores, traffic rerouting would account for an increase in sales of 0.7 percent.
RETAIL SALES SCORE = 1

3.2.2 Displacement or Renovation

DISPLACEMENT OR RENOVATION SCORE = 10

3.2.3 Ease of Deliveries and Employee Commuting

DELIVERIES AND COMMUTING SCORE = 0

3.3.4 Attractiveness of Area to Business

There is a low vacancy rate and merchants are enthusiastic about doing business in the neighborhood.
ATTRACTIVENESS TO BUSINESS SCORE $= -6$

4.1 Transportation and Land-Use Planning Process

4.1.1 Public Participation

A deliberate attempt was made to include as much public input as possible for this project, and the decision that was made truly reflects the community's preferences. The City of Seattle has established a community opinion research group to evaluate citizen input for all of their public works projects. The bridge closure was one of the first transportation projects to be evaluated under this procedure. The group distributed 1,250 questionnaires (of which 41 percent were returned) before the trial closure. Of those responding, 73 percent stated that they would be inconvenienced only slightly or not at all. After the trial period, more than 1,000 questionnaires were returned by households in the affected area from more than 3,000 distributed to households. The response was 62 percent in favor of continuing the closure permanently.
PUBLIC PARTICIPATION SCORE = 3

4.1.2 Requirements and Regulations

REQUIREMENTS AND REGULATIONS SCORE = 10

4.2 Economic Impacts

4.2.1 Tax Receipts

Any change in taxes as a result of the bridge closure will be offset by a corresponding change elsewhere in the city.
TAX RECEIPTS SCORE = 0

4.2.2 Employment

EMPLOYMENT SCORE = 0

4.2.3 Community Services

Changes in the cost of providing community services resulting from the bridge closure are minor. Some service vehicles have been rerouted, but the changes in travel time and operating costs are small.
COMMUNITY SERVICES SCORE = 0

4.3 Community Impacts

4.3.1 Community Activities

The bridge closure has unified the community somewhat because the reduction in motor vehicle traffic facilitates personal interaction among the residents. It will now be much easier to close a street for the purpose of holding a block party.
COMMUNITY ACTIVITIES SCORE = 3

4.3.2 Future Urban Plans

Closure of the 20th Avenue N.E./Ravenna Park Bridge ensures perpetuation of the residential character of the community, with no future commercial development.
FUTURE URBAN PLANS SCORE = 7

4.3.3 Construction

Construction of the facility required only the placement of some signs, warning lights, and barriers at either end of the bridge.

CONSTRUCTION SCORE = 10

Summary

Figure B-8 summarizes the evaluation variable scores for the closure of the 20th Avenue N.E./Ravenna Park Bridge.

SPARKS STREET MALL

The Sparks Street Mall, completed in Ottawa, Ont., in 1967 after a series of temporary malls beginning in 1960, is probably the most successful pedestrian mall in North America. It thus demonstrates many of the amenities that a successful mall should possess, some of which are shown on the following pages.

The mall will ultimately be six blocks in length, twice as long as was originally planned. The first, second, third, and fifth blocks have been completed. The fourth block is under construction, and the sixth block has not yet been started. This evaluation considers only the first three completed blocks of the mall.

1.1 Pedestrian Transportation

1.1.1 Travel Time

Pedestrian travel times were affected by the Sparks Street Mall in several ways. The average trip length of many commuters and other travelers to the area, who came by bus, was increased by one block (about 250 ft) because bus routes were moved from Sparks Street onto adjacent parallel streets. However, all pedestrians who crossed Sparks Street experienced average delay reductions because of elimination of vehicle traffic. Based on a computed ratio of such travel times (because no pedestrian counts are available) an estimate was made of "before" and "after" travel times.

$$\text{TRAVEL TIME SCORE} = \frac{100 - 92}{100} \times 10 = +0.8,$$

rounded to +1.

1.1.2 Ease of Walking

EASE OF WALKING SCORE = $0 + 2 + 1\frac{1}{2} + 1\frac{1}{3} + 2 = 6.8$, rounded to 7, based on the following components.

1.1.2.1 Walking Surface. The color of the walking surface is not aesthetically appealing. It consists of various shades of white, off white, dirty white, and mosaic. The texture of the surface at the center strip of the mall, which is typically for sitting, resting, and lounging rather than walking, is an aggregate compound, pleasant to the eye, whereas the primary walking surface is smoother and less interesting.

There are no gratings or unexpected surface changes. There are some severe pavement cracks scattered throughout the mall. The surface is not slippery when wet, and it is cleared of snow and ice as early as possible. In total, the comfortable, slip-free walking surface is offset by the color and the cracks. Walking Surface score = 0.

1.1.2.2 Grade Changes. All grade changes are very minor and extremely gradual. Grade Changes score = 2

1.1.2.3 Continuity. It is possible to walk from one end of the mall to the other (three city blocks) in a perfectly straight line if one so desires, although there are many alternative paths available. At any point on the mall there are two (corresponding to the previous location of sidewalks) and sometimes three pedestrian pathways. These paths vary in width from about 10 ft to 25 ft and merge at various points. The attractions and pedestrian flows make it typical to switch from one pathway to another.

There are numerous obstacles (such as benches and the cafes) on the center path, which was not designed to be a continuous route lengthwise down the mall. However, five fire hydrants remain in their original curb position. Because this is now part of the pathway, they are obstacles to pedestrian flow. Continuity score = $2\frac{1}{2} - 1 = 1\frac{1}{2}$

1.1.2.4 Signing. No maps of the mall are provided, but at each block there is a listing of the name of every store, arranged by street address for each side of the street. There are practically no signs posted on the mall. Although they are not needed for safety reasons, regulations concerning the mall are not defined. The fact that bicycle riding is forbidden is not posted; nor are the hours that trucks are permitted on the mall, except on one of the three blocks. Every traffic light cycle throughout the day includes a short phase for trucks leaving the mall, even though they are only allowed three hours per day. This causes confusion and delay.

There are no signs on the mall other than those describing the stores. Those signs are exclusively in English; but inasmuch as they are proper names no other translation is available. The letters on these store directories are only ½ in. high, but a poor-sighted person may stand as close to them as he wishes. The store directories are only at one end of each block. At the opposite end and midblock, there is no information for those who need it. Signing score = $2\frac{1}{3} - 1 = 1\frac{1}{3}$

1.1.2.5 Lighting.

Level of Illumination—The evening level of illumination of the mall varies between 15 and 23 ft-c * at most places. Under a cluster of street lights the illumination may reach 25 ft-c, and next to some particularly well-lighted shops it reaches 35 and 40-ft-c. Wellington Street, one block north of the mall and the location of the Parliament Buildings, is between 15 and 20 ft-c in illumination with no brighter spots.

Sparks Street is also colorful at night, because all of the stores are lighted. They all have flat signs against the buildings (Fig. B-9) rather than hanging signs, which adds to the effect. Level of Illumination score = 0

* To convert foot-candles to lumen per square meter (lux), multiply by 10.764.

Name of Project 20TH AVE. N.E./ RAVENNA PARK BRIDGE

Cost initial $125,000 annual $1,000 (APPROX) — Total Score $\boxed{+206}$

			Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1	Travel Time	0	1.5	0
	1.1.2	Ease of Walking	+3	2.5	8
	1.1.3	Convenience	+3	3.5	11
	1.1.4	Special Provisions	-1	3.0	-3
1.2 Motor Vehicle Transportation	1.2.1	Vehicle Travel Costs	0	0.5	0
	1.2.2	Use of Automobiles	0	1.0	0
	1.2.3	Signal/Signing Needs	-5	1.5	-8
1.3 Other Community Transportation	1.3.1	Future Transportation Plans	+5	1.5	8
	1.3.2	Existing Transportation	+5	3.0	15
2.1 Safety	2.1.1	Cost of Accidents	0	3.0	0
	2.1.2	Accident Threat	+10	2.0	20
	2.1.3	Crime Concern	-1	3.0	-3
	2.1.4	Emergency	+2	3.0	6
2.2 Attractiveness of Surroundings	2.2.1	Pedestrian Oriented Environment	-3	10.0	-30
	2.2.2	Litter Control	0	2.0	0
	2.2.3	Density	+6	2.0	12
	2.2.4	Climate Control & Weather Protection	0	2.0	0
2.3 Environment/ Health	2.3.1	Air Pollution	0	4.0	0
	2.3.2	Noise	+6	2.5	15
	2.3.3	Health	+5	2.5	13
	2.3.4	Conservation	+10	2.0	20
3.1 Residential Neighborhoods	3.1.1	Residential Dislocation	0	2.0	0
	3.1.2	Community Pride & Interaction	+4	6.0	24
	3.1.3	Aesthetics & Compatibility	+7	4.0	28
3.2 Commercial/ Industrial Districts	3.2.1	Retail Sales	+1	2.5	3
	3.2.2	Displacement or Renovation	+10	2.5	25
	3.2.3	Deliveries & Commuting	0	2.5	0
	3.2.4	Attractiveness to Business	-6	4.5	-27
4.1 Planning Process	4.1.1	Public Participation	+3	3.5	11
	4.1.2	Requirements & Regulations	+10	1.0	10
4.2 Economic Impacts	4.2.1	Tax Receipts	0	3.5	0
	4.2.2	Employment	0	2.0	0
	4.2.3	Community Services	0	1.0	0
4.3 Community Impacts	4.3.1	Community Activities	+3	5.0	15
	4.3.2	Future Urban Plans	+7	2.5	18
	4.3.3	Construction	+10	1.5	15

Figure B-8. Evaluation summary sheet for closure of 20th Avenue N.E./Ravenna Park Bridge, Seattle, Wash.

Figure B-9. Back-lighted storefront signs on Sparks Street Mall, Ottawa, Ont.

Type of Lighting. Incandescent. Type of Lighting score = 0

Height of Lamps. The poles are 9 ft (2.8 m) high, definitely pedestrian scale. Height of Lamps score = 0

Lighting Score. Lighting score = 0 + 0 + 0 + 2 = 2

1.1.3 Convenience

1.1.3.1 Time Facility is Open for Use. The Sparks Street Mall is open at all hours of the day and night. Time Facility is Open for Use score = 0

1.1.3.2 Improved Travel Convenience to:

Transit	No	Buses and streetcars previously traveling on Sparks Street were rerouted.
Parking	No	On-street parking was eliminated from Sparks Street Mall.
Transportation terminals	No	No major transportation terminals are within walking distance of the mall.
Bike routes	Yes	Two major bicycle paths in Ottawa parallel the Rideau Canal and the Ottawa River. Their termini are not presently connected, hence one must travel across about a dozen city blocks in the heart of downtown to get to the other. A future connecting bikeway is proposed, but until it is completed Sparks Street is a very attractive alternative among the various routes available, even though bike riding is prohibited on the mall.
Schools	No	There are no schools nearby.
Parks or cultural facilities	Yes	Travel to the Garden of Provinces, just off the western end of the planned mall extension, will be improved. Travel to nearby Parliament buildings, the National Gallery, and the National Library and Archives is improved.
Medical facilities	No	No doctors' office complexes, clinics, or hospitals are located nearby.
Places of worship	Yes	St. Andrew's Church (Presbyterian) is located on the mall, and St. Peter's Evangelical Lutheran Church will be on the mall when it is extended.
Retail stores	Yes	Access to the retail stores on Sparks Street is greatly improved.
Residential areas	No	There are no residential neighborhoods nearby.

Accessibility score = 4

CONVENIENCE SCORE = 4

1.1.4 Special Provisions

		point	
6-in. (15 cm) maximum curb height	Yes	1	
Ramped curb cuts	No	0	The curbs are sloped slightly at crossings, but are not cut.
5-ft (1.5 m) wide passageway	Yes	1	There is a 20-ft wide (6.1 m) passageway designed to accommodate emergency and service vehicles.
Interior areas	No	1	The mall is outdoors.
Grade changes without ramps or elevators	No	1	There are no grade changes greater than 15 ft (4.6 m) on the mall.
Crossing signal buttons	No	1	There are no pedestrian-activated signals.
Public telephone	No	0	The telephones have 32-in. (81 cm) clearance underneath, but the touch tone panel is 55 in. (1.4 m) high.
Drinking fountain	No	0	The drinking fountains are approximately 36 in. (91 cm) above the ground.
Pavement texture	No	0	There are no changes in pavement texture for the benefit of blind people.
Special provisions for blind people	No	0	There are no braille signs or other accommodations.
Angular corners	No	0	There are no angular sidewalk corners.
Audible signals	Yes	3	At the signal control box, there are four clicks before the pedestrian phase, and eight clicks for the vehicle phase. The control box is located only on one side of the street. However, because of the mall, there is a crossing only of one street, and the noise of vehicles and pedestrians is discernible from the side of the street opposite the control box.
Bicycle racks	Yes	3	There is a bike rack on each of the three blocks of the mall; one holds 8, the other two each hold 11. Bikes are not allowed to be tied to posts or other places on the mall; however, this rule is rarely enforced, especially now that people are using the bike racks and they are sometimes filled to capacity. Figure B-10 shows one of the bicycle racks.
Separate bicycle path	No	0	It is against the law to ride a bicycle on the mall.
Jogging path	No	0	No provisions are made for joggers; it is rare to see a person jogging through the mall.
Handrails	No	1	There are no hazardous locations.
Gratings	No	1	There are no gratings.

SPECIAL PROVISIONS SCORE is $13 \times 0.8 - 10 = 0.4$, rounded to 0

1.2 Motor Vehicles

1.2.1 Motor Vehicle Travel Costs

Although it cannot be based on hard data, the Sparks Street closure probably reduced motor vehicle travel costs slightly, because traffic on the street was often congested.

VEHICLE TRAVEL COSTS SCORE = 1

1.2.2. Use of Automobiles

The Sparks Street Mall probably accounted for only a very minor change in the fraction of trips made to central Ottawa by automobile.

USE OF AUTOMOBILES SCORE = +1

1.2.3 Signal/Signing Needs Adjacent to Facility

Very few signs were posted to inform motorists of the Sparks Street closure.

SIGNAL/SIGNING NEEDS SCORE selected = 0

1.3 Other Community Transportation

1.3.1 Adaptability to Future Transportation Development Plans

The Sparks Street Mall is located at the center of the city, and thus is at the focus of its pedestrian, transit, and bicycle routes. It contributes a positive dimension to these modes.

FUTURE TRANSPORTATION PLANS SCORE selected = 5

1.3.2 Impact on Existing Transportation Systems

The Sparks Street Mall does not impact any transportation terminals, and the only mode affected by the mall was transit. A number of lines had to be rerouted one block, requiring people to walk an extra block to get to the stores on Sparks Street. A positive impact of the rerouting was a decrease in transit operating costs, presumably because

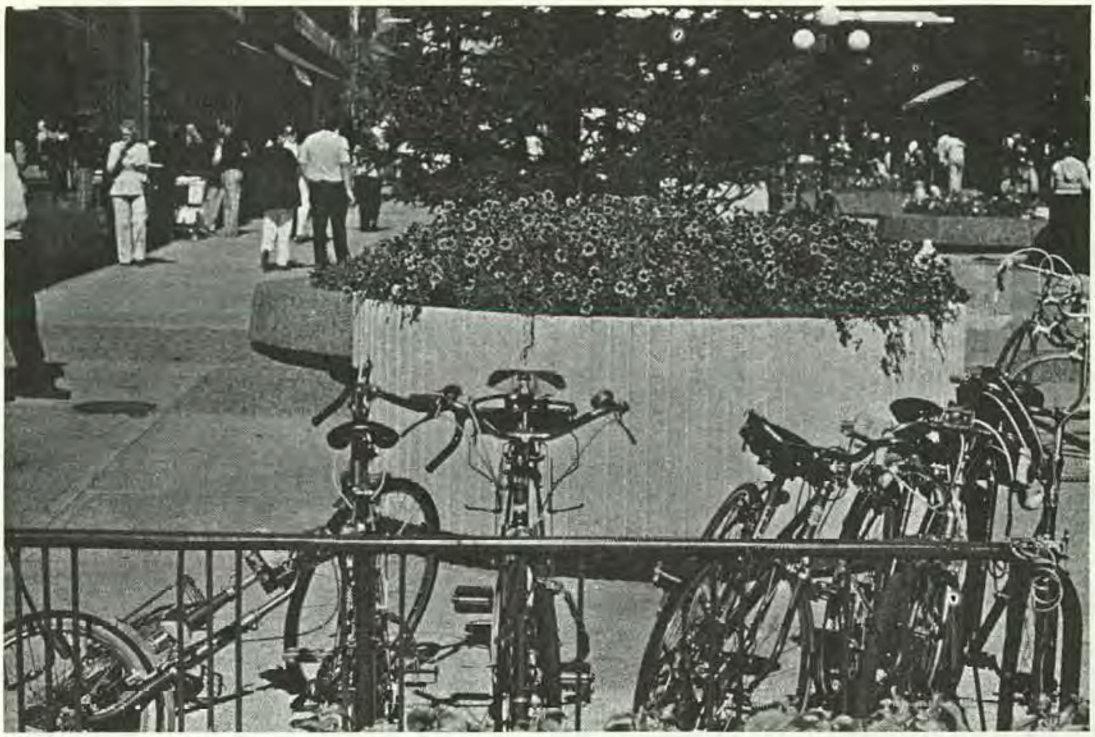


Figure B-10. Bicycle rack on Sparks Street Mall.

buses could avoid the stop-and-go traffic on congested Sparks Street. These two impacts tend to offset each other.

EXISTING TRANSPORTATION SCORE selected = 0

2.1 Safety

2.1.1 Societal Cost of Accidents

The major shopping area of the Sparks Street Mall is the three-block section from Bank to Elgin Streets. Since the mall was completed in 1967, exact pedestrian and vehicle movement is unavailable for evaluation. However, because it is a shopping and business area, with only the cross streets remaining open to vehicle traffic, a 50 percent reduction in pedestrian/vehicle crossing conflicts is estimated. This agrees with the observation that before the mall was put in pedestrian trips probably avoided crossing any street more than necessary due to the presence of vehicle traffic. Today pedestrian crossings of the previous roadway (Sparks Street) far exceed the number of cross-street crossings (O'Connor and Metcalf) because of the elimination of vehicle traffic.

The accident scoring system is designed so the ratio of before and after crossings can be used, as well as actual crossing counts; in this case, 2 to 1. The "before" accident involvement rate was calculated to be 1.05. using Figure A-13 (Appendix A). An "after" ratio of 0.74 was calculated, largely due to reductions in vehicle volume and turning conflict.

COST OF ACCIDENTS SCORE =

$$\frac{(2 \times 1.05) - (1 \times 0.74)}{(2 \times 1.05)} \times 10 = +6.48\text{, rounded to } +6$$

2.1.2 Accident Threat Concern

The assessed vehicle factors in the Sparks Street Mall area (including cross streets) are: low traffic volume, medium traffic speeds, few turning conflicts (only during loading and unloading period, and occasionally during the rest of the day for special delivery, maintenance, and emergency vehicles), and mixed vehicle types on one-way streets. The vehicle factors yield +4 points.

The setting provides marked crosswalks, signalization for pedestrians and vehicles, good sight distances and good lighting when needed. These yielded +4 points.

ACCIDENT THREAT SCORE is +8

2.1.3 Crime Concerns

Crime concern is at a remarkably low level on the Sparks Street Mall because of many factors (only one window was broken by vandalism in 10 years). Highly visible police patrols (very friendly), high pedestrian volume, good lighting, little clutter, low vehicle traffic, and gentle discouragement of panhandlers, alcoholics, and other nuisance loiterers contribute to a very comfortable feeling in the area.

CRIME CONCERN SCORE is +8

2.1.4 Emergency Access/Medical and Fire Facilities

Full emergency vehicle access is provided by a minimum 25-ft wide unmarked serpentine path through the entire mall. It is unusual in that the pedestrian is unaware of its existence because the emergency path is simply the widest pedestrian path with the required width and gentle turning

Figure B-11. Emergency vehicle access on Sparks Street Mall.

radii necessary for emergency vehicles. Figure B-11 shows a police car rushing to the scene using the path.

High pedestrian volumes, good lighting, and telephones on the mall that do not require coins for emergency calling minimize the danger of unattended medical emergencies.

EMERGENCY SCORE = +6

2.2 Attractiveness of Surroundings

2.2.1 Pedestrian-Oriented Environment

Amenities (2 points/2 possible). There is a small Provincial Rock Garden (Fig. B-12) in the center block of the mall containing a rock from each province or territory. There is a water fountain (Fig. B-13) on each block of the mall. The fountain on the middle block also has a small waterfall.

The Arts (4 points/6 possible). There is a 15 by 19 ft (4.6 x 5.8 m) stage, 1½ ft (46 cm) above the ground, with an overhead canopy, near the western end of the mall. The stage is shown in Figure B-14. Performances are held there at least twice a week in the summer. There are no murals, but the metal sculpture "Joy," four happy people by Bruce Garner, sits near the eastern end of the mall. Guitarists and other street musicians play on weekdays, particularly during the lunch hours. They are not allowed to request or indicate that they will accept donations, for the same reason the street artists are not allowed to sell their products on the mall. A major purpose of the mall is to provide a refuge for one to be able to sit and not be solicited. There is background music playing from speakers in the telephone/drinking fountain/directory kiosk on each block of the mall, but its volume is such that it can be heard only on less than one-third of the block. Thus, a person on the mall can choose to sit near or away from the music, as he prefers.

Buildings (1 point/2 possible). There is a wide variety of heights, colors, and designs of buildings facing the mall. The Bank of Nova Scotia (see Fig. B-15) and the Canadian Bank of Commerce Buildings, side by side, are particularly impressive. No renovations or restorations have been attempted.

Communications (3 points/3 possible). Mailboxes are located just off the mall at each intersection and there is a post office on Sparks Street at the eastern end of the mall. There is a stamp machine on each block of the mall, adjacent to the public telephones, of which there are two at the center of each block on the mall. Figure B-16 shows some of the public telephones. No coin is needed to call the operator.

On each block of the mall, there is an outdoor clock. One is actually a part of the mall; the others are attached to banks that face the mall.

Exhibits (2 points/2 possible). There are twelve 92 x 42 in. (2.3 x 1.1 m) display cases on the westmost block of the mall, and a four-sided 41 x 83 in. (1.0 x 2.1 m) display box at the eastern end of the mall. They are used mostly for tasteful exhibits by local merchants located both on and off the mall, particularly photographers and art galleries (Fig. B-17). Sample displays of a store's merchandise are not permitted. There are some additional exhibits in store windows.

At the western front of the mall there is a monument to

Figure B-12. Provincial Rock Garden, Sparks Street Mall.

Nicholas Sparks (1792-1862), who bought all of downtown Ottawa for £95 in 1826. Much of this land he later donated to the city, including two blocks (at that time all) of Sparks Street. Near the other end of the mall is a plaque commemorating the Vincent Massey Urban Environment Excellence Award, given to the people of Ottawa in 1971 for the Sparks Street Mall.

Nature (3 points/4 possible). There are 22 to 26 trees of various types and sizes on each block of the mall. There

Figure B-13. Fountain and delivery trucks, Sparks Street Mall.

Figure B-14. Stage on Sparks Street Mall.

are also 31 to 35 separate flower boxes, plantings, or gardens on each block of the mall. There are no additional flower exhibits. Approximately 18 to 20 sparrows live in the trees on the mall.

Outdoor Eating (2 points/2 possible). There are three sidewalk cafes on the mall, one on each block. The westernmost one is small, serving only ice cream, hot dogs, ham sandwiches, and cold drinks. There are six picnic tables with umbrellas. On the center block, Sharry's outdoor cafe is associated with the adjacent dining room and lounge of the same name. They serve a variety of light chicken, beef, fish, and pizza dishes, sandwiches, non-alcoholic beverages, and beer. Open Air Cafeteria (Fig. B-18), has five round shaded tables for enjoyment of ice cream, hamburgers, hot dogs, and cold drinks. On weekdays, there is a fruit cart (Fig. B-19) and an ice cream cart on each block of the mall.

Physical Comfort (3 points/5 possible). The 38 benches

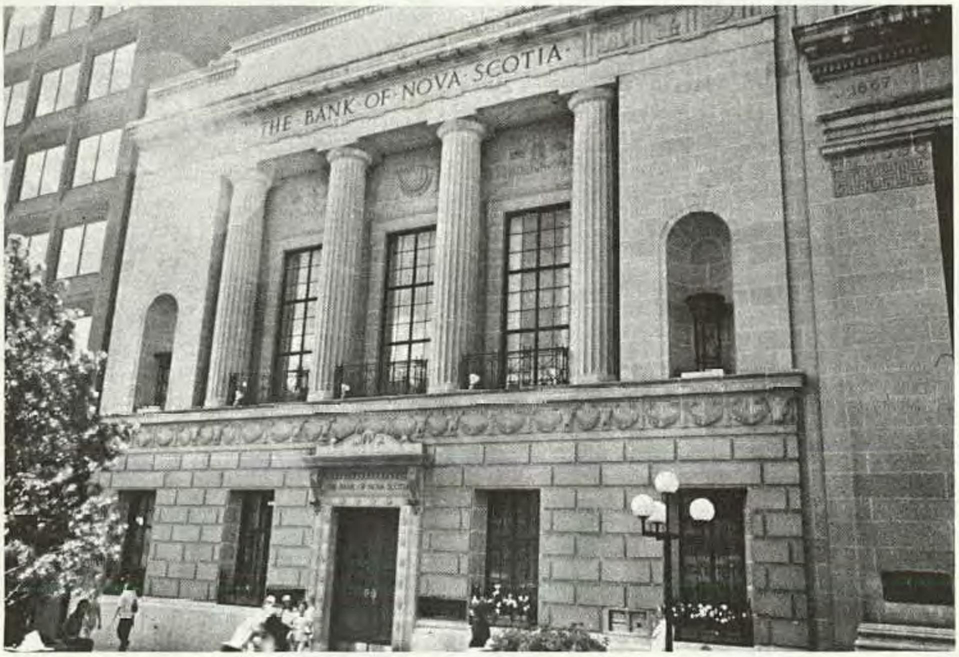


Figure B-16. Telephone kiosk, Sparks Street Mall.

Figure B-17. Display case, Sparks Street Mall.

Figure B-18. Cafe on Sparks Street Mall.

on the mall are only 18 in. (46 cm) deep, and 92 in. (2.3 m) long (two on each block are only 68 in. (1.7 m) long). They are uncomfortable to sit on for long periods of time, although they are attractive and conveniently located. There are eight temporary benches due to the construction of a new building. Ledges on the mall have the capacity for seating more than twice as many people as the benches. The ledges are about 23 in. (58 cm) high, and 12 in. (30 cm) deep, and are heavily used during lunch hours, but also at times when there are empty benches available.

There is a drinking fountain on each block of the mall, next to the telephones. There are plenty of lampposts and building fronts available to lean against. No restrooms are provided, because the operating costs would more than double the entire operating budget for the mall.

Retail Outlets (4 points/4 possible). There is a flower cart (Fig. B-20) on each block of the mall on weekdays. Each of the 70 different shops facing the mall has something to catch the eye of the passerby. Figure B-21 shows a typical storefront. There are two bookstores and one newsstand on the mall.

Positive Impacts score = 24 out of possible 30; Negative Aspects score = 0.

PEDESTRIAN ENVIRONMENT SCORE = 24 ÷ 2 − 5 = 7

Figure B-19. Fruit vendor on Sparks Street Mall.

Figure B-20. Flower cart on Sparks Street Mall.

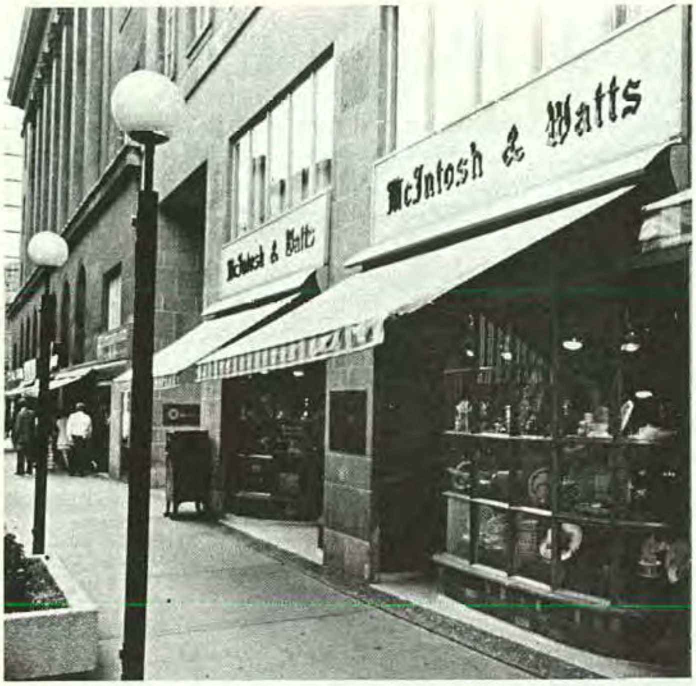


Figure B-21. Interesting storefront display, Sparks Street Mall.

2.2.2 Litter Control

Litter condition is 2.5—littered. There are more than slight accumulations of dirt and litter. Cigarette butts and matches, in particular, accumulate in and around sidewalk cracks and especially under benches. The mall is swept mechanically several times daily (Fig. B-22), but the machine cannot pick up all of the litter generated by the tens of thousands of people who use the facility daily. There is a noticeable accumulation of gum residue present. Litter Condition score = −8.

There is adequate placement of trash baskets, many, many more than on nearby streets in Ottawa. Existence of Trash Baskets score = +8.

LITTER CONTROL SCORE = 0

2.2.3 Density

The weekday lunch-hour pedestrian density on Sparks Street is about 15 sq ft (1.4 m^2) per person. No records were available as to the pedestrian density before Sparks Street was converted to a mall, when there were fewer pedestrians and less walking space, but it is believed that there is more available walking space per person now.

DENSITY SCORE selected = −4

2.2.4 Climate Control and Weather Protection

Because the facility is outdoors it is neither heated nor air conditioned. Ventilation is unnecessary.

The pedestrian is protected from direct sun, precipitation, gusts of wind, and snow accumulations. On each block, trees and canopies provide shade from the sun, in addition to that at the outdoor cafes. The canopies above the telephones provide shielding from direct precipitation for up to three dozen people comfortably and up to perhaps double that, if necessary, at each block. These canopies are more than 12 ft high and open at the sides. Because of their length and orientation, they may provide

Figure B-22. Street cleaner at work, Sparks Street Mall.

protection from rain coming straight down or from the north or the south (perpendicular to the mall), but they offer no protection from rain that is coming down from the east or west.

Most winds are from the west and the north, and thus are effectively blocked by the buildings on the north side of the mall.

The city gives Sparks Street first priority in snow removal, so the mall is cleared immediately after a snowfall. There is adequate drainage for rainwater.

CLIMATE AND WEATHER SCORE = 0 + 0 + 0 + 4 − 10 = −6

2.3 Environment/Health

2.3.1 Effects of Air Pollution

The position of Sparks Street in the previous traffic pattern was such that through traffic was forced to move to an adjacent parallel street within a few blocks on one end, and no through street existed at the other end. Thus few vehicle trips increased in length as a result of the street closure, inasmuch as the cross streets remained open.

A major contributor to air pollution is vehicle traffic congestion, and the narrow street plus heavy pedestrian traffic resulted in heavy congestion on the old street. Today, with the pedestrians concentrated on the mall, slightly increased volume on other streets probably moves better than before the mall was opened.

It was therefore estimated that 20 percent of the area traffic (from old Sparks Street) was rerouted to other streets, and that the average travel speed for this 20 percent increased from 15 to 20 mph (24 to 32 kph) because it no longer competed with pedestrians for space. The remaining traffic (80 percent) was estimated to be unaffected. The formulas for computing emission changes can also be used with vehicle volume ratios, as well as with actual vehicle counts. Because old data were not available (the Mall was completed in 1967) the formulas were computed using 10 vehicle-miles per day (vm/d) at 20 mph (32 kph) with 2 vm/d at 15 mph (24 kph) as the old (before) situation. Calculation yielded a 3 percent emission volume reduction, which translates to a +5 score using Figure A-21.

AIR POLLUTION SCORE = +5

2.3.2 Noise Impacts of Motor Vehicles

Noise effects on humans are difficult to determine. The same noise level (measured in decibels) is perceived differently by different people, depending on its source. Human speech may be tolerated, but a vehicle at the same noise level may be annoying. This variable considers the speech interference impact; perception is considered with health impacts (2.3.3).

Average sound level readings were taken at several points throughout the mall and at the cross streets; they varied from 70 db(A) to 52 db(A). Midblock values ranged from 52 to 58, so a value of 56 db(A) was selected as representative of most of the mall area. The scaled value was computed using Eq. A-17 (see Sec. 2.3.2 in Appendix A).

NOISE SCORE = $-10 + [(90 - 56) \times 0.4] = +3.6$, rounded to +4

2.3.3 Health Effects of Walking

Convenient resting places are available throughout the mall in the form of benches and many ledges. It is an exceptionally pleasant and attractive area providing psychological comfort because it is aesthetically pleasing, has low noise levels, and is essentially free of crime. However, the Sparks Street Mall does not significantly improve access to physical exercise facilities, nor does it provide for bicyclists or joggers.

HEALTH SCORE = +4

2.3.4 Conservation of Resources

Maintenance of the mall requires minimal amounts of all resources, including labor (the equivalent of one full-time groundskeeper, plus the street cleaning and police patrols).

CONSERVATION SCORE = +10

3.1 Residential Neighborhoods

3.1.1 Residential Dislocation

Sparks Street Mall is located in a commercial area, thus no residential relocation was necessary for its construction or continuation.

RESIDENTIAL DISLOCATION SCORE = 0

3.1.2 Community Pride, Cohesiveness, and Social Interaction

Although not located in a residential area, the Sparks Street Mall is enjoyed by city residents, business people, and tourists. It provides a place to meet and visit friends, access to many shops, a pleasant route to art and activity centers, and freedom from motor vehicles.

COMMUNITY PRIDE AND INTERACTION SCORE = +4

3.1.3 Aesthetic Impact, Compatibility with Neighborhood

This variable is only applicable to facilities in residental areas.

AESTHETICS AND COMPATIBILITY SCORE = 0

3.2 Commercial/Industrial Districts

The ratings for gross retail sales, as well as for displacement and renovation costs, are based on changes from the existing situation. Because the first temporary mall on Sparks Street began in May 1960, it is impossible to acquire quantitative data about the situation before that time, even from the businessmen who were instrumental in development of the mall. Therefore, the values given in the observations for variables 3.2.1 and 3.2.2 have been assumed.

3.2.1 Gross Retail Sales

Property values on Sparks Street tripled in value during the first ten years of the permanent mall. Suppose instead that the total volume of sales transacted on the mall tripled, whereas in other parts of the city they merely doubled. The average annual growth of sales on Sparks Street is thus

11.6 percent over the 10-year period, whereas it is only 7.2 percent for the remainder of the city. The difference, 4.4 percent, is the average annual growth in sales attributable to the pedestrian mall. If the rate of growth were uniform for the 10-year period, the average annual growth for the first two years would be equal to that for the first ten years, 4.4 percent.

RETAIL SALES SCORE selected = +4

3.2.2 Displacement or Renovation Required or Encouraged

The following is a specimen worksheet for this variable. The total renovation and cleaning costs are $81,700. If the total sales volume for the year before the permanent mall was installed was $2,000,000, the 4.4 percent average annual increase in sales would account for $88,000 in additional sales. The ratio of renovation costs to annual change in sales is $81,700/$88,000 = 0.93. Interpolating from the table gives a score of +0.7, rounded to +1.

	Relocation	Storefront Renovation	Building Cleaning	Total
Store (or building) type			OFFICE	
Name of typical store (or building) type			METROPOLITAN LIFE	
Frontage for typical store (or building)			300′	
Cost for typical store (or building)			$5,000	
Total frontage and/or number of stores (or buildings) in group			2500′	
Total costs for group			$41,700	
Store (or building) type		VARIETY		
Name of typical store (or building)		DAVIS GALLERY		
Frontage for typical store (or building)		50′		
Cost for typical store (or building)		$4,000		
Total frontage and/or number of stores (or buildings) in group		10 STORES		
Total costs for group		$40,000		

DISPLACEMENT OR RENOVATION SCORE = +1

3.2.3 Ease of Deliveries and Employee Commuting

Trucks are prohibited from the mall except between 8 and 10 a.m. and 6 and 7 p.m. (see Fig. B-13).

DELIVERIES AND COMMUTING SCORE = −5

3.2.4 Attractiveness of Area to Business

All of the components of this variable are favorable except for interest by out-of-town firms to move into the area, and special promotional activities.

ATTRACTIVENESS TO BUSINESS SCORE = 16 − 10 = +6

4.1 Transportation and Land Use in the Planning Process

4.1.1 Public Participation in the Planning Process

The decision to construct a permanent pedestrian mall on Sparks Street was made by the local merchants and ratified by the property owners. However, in order "to get a broader, more objective appraisal of the mall's value to the community and downtown . . . a Citizen's Committee was formed" in 1963. The Committee was comprised of "representatives from local women's groups, architects, property owners, and citizens at large."

PUBLIC PARTICIPATION SCORE selected = +6

4.1.2 Conformance with Requirements and Regulations

The original design for the mall complied with all existing requirements, codes, and regulations.

REQUIREMENTS AND REGULATIONS SCORE selected = +10

4.2 Economic Impacts

4.2.1 Change in Tax Receipts and Other Government Revenues

The impact of the mall on municipal receipts in Ottawa is negligible because most of the increase in retail sales is simply a diversion from elsewhere, much of which is within the City of Ottawa. Also, motor vehicle fines that are no longer collected as a result of the mall will probably be accounted for elsewhere in the city.

TAX RECEIPTS SCORE selected = 0

4.2.2 Changes in Employment

One caretaker is employed by the Mall Authority to maintain the mall, and additional sales positions created probably number no more than 20. No jobs were lost as a result of the mall.

EMPLOYMENT SCORE selected = +2

4.2.3 Change in Cost of Providing Community Services

The Pedestrian Mall Authority maintains its own budget as a separate account in the city's books. Additional community service costs (principally cleaning of the pavement) beyond those incurred prior to Sparks Street being closed to traffic are charged to that account, which is reimbursed by property owners in the special assessment district on a front footage basis. The level of police protection (one officer patrolling the mall at all times) is the same as it was before the street was closed to traffic. Sparks Street is given priority by the city in snow clearance. but this does not incur any additional costs. Thus, the city's general budget has been unaffected by the mall.

COMMUNITY SERVICES SCORE selected = 0

4.3 Community Impacts

4.3.1 Community Activities

A number of concerts, acts, and other performances are held on the mall. They are generally well-attended, especially during the summer, on weekdays just after the lunch hour.

COMMUNITY ACTIVITIES SCORE selected = +10

4.3.2 Adaptability to Future Urban Development Plans

One long-term plan that has a number of supporters in Ottawa would have Sparks Street as a bridge connecting two other pedestrian/shopping malls. They are the Bank Street Promenade, intersecting with the west end of Sparks Street Mall, and the Rideau Street Mall, just opposite Confederation Square from Sparks Street. Bank Street will continue to accommodate vehicular traffic, expanding on some of the existing pedestrian amenities, whereas plans for the Rideau Mall call for having it enclosed.

Whether or not these plans actually come to fruition, the Sparks Street Mall still will continue to exert a pedestrian-social-commercial atmosphere in downtown Ottawa.

FUTURE URBAN PLANS SCORE selected = +10

4.3.3 Construction Period

Construction of the mall caused slight disbenefits to pedestrian movement, safety, and the pedestrian environment. However, these were offset by two characteristics—impacts on local businesses, and the length of construction. A large number of curious people came to Sparks Street to watch construction of the mall progress; as a result, sales improved. The construction period was short, requiring only three months (March 27 to June 28, 1967).

CONSTRUCTION SCORE = 0

Summary

Figure B-23 summarizes the evaluation variable scores for the Sparks Street Mall.

FULTON MALL

A pedestrian and transitway protected by an overhead canopy is planned for Fulton Street in the busy downtown shopping district of Brooklyn, N.Y. Detailed plans and cost estimates are currently being developed. Schematic design work is almost complete. Detailed site information and scoring of variables, followed by a project summary sheet, are presented in the following.

1.1 Pedestrian Transportation

1.1.1 Travel Time

A major reason for the Fulton Mall is to improve pedestrian flow through the area. Congestion presently is so high that average walking speeds are 10 to 12 percent lower than they could be with the increased walking space the project would provide.

The street-crossing problem is less clear. Cross-street traffic will continue, so no savings in pedestrian travel time will result from these crossings unless signal timing is changed significantly. Also, pedestrian crossings of Fulton Street may continue to be delayed because of bus volumes at peak hours. It is the understanding of the researchers that crossings of Fulton Street by pedestrians will be restricted to specific locations, probably with signalization.

If the restrictive patterns described are followed, minimal reductions in pedestrian travel time will result. Based on an 18 percent reduction in equivalent pedestrian travel time,

$$\text{TRAVEL TIME SCORE} = \frac{100\% - 82\%}{100\%} \times 10 = +1.8, \text{ rounded to } +2$$

1.1.2 Ease of Walking

EASE OF WALKING SCORE = 8, based on rounded sum of the following components.

1.1.2.1 Walking Surface. There is a great variety of pavement types, textures, and colors on each block of Fulton Street at present. There are three basic major colors—steel blue, off-white, and off-beige, plus some beautiful gray slate at two locations. The texture ranges from smooth to brushed, plus fine, medium, and coarse aggregates. Figure B-24 shows a particularly interesting pavement pattern outside the Off-Track Betting Corporation Office on Fulton Street. Walking Surface score = 1½

1.1.2.2 Grade Changes. Grade Changes score = 2

1.1.2.3 Continuity. Continuity score = 2

1.1.2.4 Signing. Signing score = 1⅓

1.1.2.5 Lighting. Lighting score = 1

1.1.3. Convenience

The Mall will improve accessibility to all of the attractions listed in Section 1.1.3.2, except bicycle paths. The Polytechnic Institute of New York, Brooklyn Law School, New York City Community College, the Zeckendorf Campus of Long Island University, and a part of Brooklyn College are all within walking distance of Fulton Street. Nearby residential Brooklyn Heights is a National Historic Landmark.

CONVENIENCE SCORE = 9

1.1.4 Special Provisions

The expected Federal Government participation in the funding of the Fulton Mall (as a tarnsit development project) ensures that it will satisfy the needs of the physically handicapped, but it is not yet clear that the design will accommodate many other special provisions.

SPECIAL PROVISIONS SCORE = −2

1.2 Motor Vehicles

1.2.1 Motor Vehicle Travel Costs

1.2.1.1 Motor Vehicle Operating Costs and 1.2.1.2 Travel Time for Motor Vehicle Occupants. A consultant's study (Wilbur Smith and Associates, 1974) shows that the traffic reassignment impacts of the Fulton Street closure would be minor at all times except the weekday evening peak hours, when 11 of the 115 major intersection approaches in the study area (9½ percent) would experience an increase in the volume/capacity ratio from below 0.6 to the 0.61 to 0.9 range, and three intersection approaches (2½ percent of the 115 in the study area) would experience an increase in the volume/capacity ratio from the

Name of Project SPARKS STREET MALL

Cost initial $1,500 000 annual $34,800

+391 Total Score

			Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1	Travel Time	+1	1.5 %	2
	1.1.2	Ease of Walking	+7	2.5	18
	1.1.3	Convenience	+4	3.5	14
	1.1.4	Special Provisions	0	3.0	0
1.2 Motor Vehicle Transportation	1.2.1	Vehicle Travel Costs	+1	0.5	1
	1.2.2	Use of Automobiles	+1	1.0	1
	1.2.3	Signal/Signing Needs	0	1.5	0
1.3 Other Community Transportation	1.3.1	Future Transportation Plans	+5	1.5	8
	1.3.2	Existing Transportation	0	3.0	0
2.1 Safety	2.1.1	Cost of Accidents	+6	3.0	18
	2.1.2	Accident Threat	+8	2.0	16
	2.1.3	Crime Concern	+8	3.0	24
	2.1.4	Emergency	+6	3.0	18
2.2 Attractiveness of Surroundings	2.2.1	Pedestrian Oriented Environment	+7	10.0	70
	2.2.2	Litter Control	0	2.0	0
	2.2.3	Density	-4	2.0	-8
	2.2.4	Climate Control & Weather Protection	-6	2.0	-12
2.3 Environment/ Health	2.3.1	Air Pollution	+5	4.0	20
	2.3.2	Noise	+4	2.5	10
	2.3.3	Health	+4	2.5	10
	2.3.4	Conservation	+10	2.0	20
3.1 Residential Neighborhoods	3.1.1	Residential Dislocation	0	2.0	0
	3.1.2	Community Pride & Inter-action	+4	6.0	24
	3.1.3	Aesthetics & Compatibility	0	4.0	0
3.2 Commercial/ Industrial Districts	3.2.1	Retail Sales	+4	2.5	10
	3.2.2	Displacement or Renovation	+1	2.5	3
	3.2.3	Deliveries & Commuting	-5	2.5	-13
	3.2.4	Attractiveness to Business	+6	4.5	27
4.1 Planning Process	4.1.1	Public Participation	+6	3.5	21
	4.1.2	Requirements & Regulations	+10	1.0	10
4.2 Economic Impacts	4.2.1	Tax Receipts	0	3.5	0
	4.2.2	Employment	+2	2.0	4
	4.2.3	Community Services	0	1.0	0
4.3 Community Impacts	4.3.1	Community Activities	+10	5.0	50
	4.3.2	Future Urban Plans	+10	2.5	25
	4.3.3	Construction	0	1.5	0

Figure B-23. Evaluation summary sheet, Sparks Street Mall.

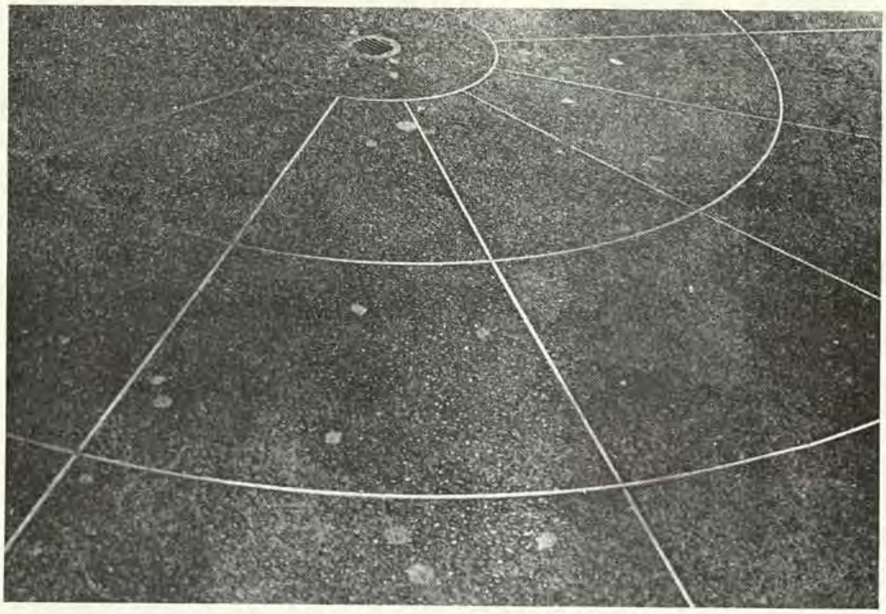


Figure B-24. Interesting pavement pattern on Fulton Street.

0.91 — 1.0 range to a fraction greater than one. Using the 25-mph speed limit (applicable to streets in New York City) in the lower left-hand nomograph of Figure A-7 (Basic Section Costs for Passenger Cars on Arterials); volume/capacity ratios of 0.60, 0.75, and 0.95 to represent the classes of congestion at intersection approaches; and the "level" line in the center nomograph of Figure A-7, extension to the "travel time" and "tangent running cost" axes gives the following.

- For 11 intersection approaches, travel costs increase 1.5 percent, from $70 to $71 per 1,000 veh-mi, and travel time increases 4 percent, from 50 to 52 hr per 1,000 veh-mi.
- For the three intersection approaches at which volume begins to exceed capacity, vehicle operating costs increase 5 percent, from $72.5 to $76 per 1,000 veh-mi, and travel time increases approximately 21 percent, from 62 to 75 hr per 1,000 veh-mi.

Multiplying the increase in travel time and operating costs by the fraction of intersections affected (using the simplifying assumption that traffic volume through the 115 intersection approaches is evenly distributed), it is determined that travel costs increase by only 0.25 percent and travel time increases 0.9 percent.

1.2.1.3 Parking Costs. At present, no parking is allowed on Fulton Street in the area that is to be closed. Some side-street parking spaces will be eliminated, but ample off-street parking is available; no major changes in parking are expected.

1.2.1.4 Vehicle Ownership. The Fulton Mall will have no effect on motor vehicle ownership in Brooklyn.

1.2.1.5 Total Motor Vehicle Travel Cost. If total motor vehicle travel time value and operating costs are assumed to be approximately equal, the average of the increases in these two components (about 0.6 percent) will equal the increase in motor vehicle travel costs. Eq. A-12 then yields

$$\text{VEHICLE TRAVEL COSTS SCORE} = \frac{1 - 1.006}{1.006} \times 10 = -0.06, \text{ rounded to } 0$$

1.2.2 Use of Automobiles

The total daily mode split in downtown Brooklyn is currently extremely high—73.6 percent according to an unpublished downtown Brooklyn transportation user survey prepared by the New York City Planning Commission. The Fulton Mall would probably not cause the mode split to increase beyond 75 percent.

USE OF AUTOMOBILES SCORE = +1

1.2.3 Signal/Signing Needs Adjacent to Facility

Signs will be needed throughout the downtown area to warn motorists of the Fulton Street closure.

SIGNAL/SIGNING NEEDS SCORE = −5

1.3 Other Community Transportation

1.3.1 Adaptability to Future Transportation Development Plans

No other new major transportation routes are planned for the area that will be affected by the Fulton Mall.

FUTURE TRANSPORTATION PLANS SCORE = 0

1.3.2 Impact on Existing Transportation Systems

The Fulton Mall will greatly improve Brooklyn's bus operations in this currently congested area (see Fig. B-25).

EXISTING TRANSPORTATION SCORE = +6

2.1 Safety

2.1.1 Societal Cost of Accidents

As a major shopping and business area, significant cross-street traffic is expected to remain. Therefore, a 50 percent reduction (for through traffic) in pedestrian/vehicle conflicts is estimated. This includes an estimate of the number of accidents likely to occur on Fulton Street between pedestrians and buses. This situation may be more hazardous than estimated because pedestrians are likely to consider (incorrectly) the Mall as a vehicle-free mall with unlimited crossing privileges.

The "before" accident involvement rate was estimated to be 0.91, and the "after" rate was estimated at 0.72, the difference being largely due to reductions in vehicle volumes and turning conflicts.

COST OF ACCIDENTS SCORE =

$$\frac{(2 \times 0.91) - (1 \times 0.72)}{2 \times 0.91} \times 10 = +6.04, \text{ rounded to } +6$$

2.1.2 Accident Threat Concern

Fear of accidents is estimated to be very low, resulting in a high score. Factors contributing to this perception are relatively low traffic volumes and speeds, a reduction in turning conflicts, signalization, and good sight distances in many cases.

ACCIDENT THREAT SCORE = +8

2.1.3 Crime Concern

Police patrol frequency and presence of others reduce concern for crime; but idlers, clutter caused by some merchants' practices, and much litter increase these fears.

CRIME CONCERN SCORE = +4

2.1.4 Emergency Access/Medical and Fire Facilities

Adequate access for emergency vehicles is planned for the Mall. However, communications and medical facilities are very limited.

EMERGENCY SCORE = +4

2.2 Attractiveness of Surroundings

2.2.1 Pedestrian-Oriented Environment

A large metal sculpture by Bolomey (Fig. B-26) now stands at Albee Square. The major department stores have already begun to renovate their exteriors.

PEDESTRIAN ENVIRONMENT SCORE = +1

2.2.2 Litter Control

Fulton Street is currently heavily littered, there are significant accumulations of gum residue present, and the trash baskets are often overflowing because they are not emptied frequently enough. Planned addition of maintenance teams will probably improve this situation somewhat.

LITTER CONTROL SCORE = −4

Figure B-25. Buses constitute a large percentage of traffic on Fulton Street.

Figure B-26. Large metal sculpture in Albee Square, Fulton Street.

2.2.3 Density

On weekday afternoons there is frequently less than 15 sq ft (1.4 m^2) per person, according to our own observations as well as a consultant's report (DMJM et al., undated). The Mall may double available walking space in many places. If the number of pedestrians does not increase, about 30 sq ft (2.8 m^2) would be available per person.

DENSITY SCORE = +4

2.2.4 Climate Control and Weather Protection

The Mall would protect pedestrians from precipitation and puddles, but not from sun, heat, or cold.

CLIMATE AND WEATHER SCORE = −8

2.3 Environment/Health

2.3.1 Effects of Air Pollution

As discussed in Motor Vehicle Travel Costs (1.2.1), increased vehicle congestion, and thus increased air pollution, will occur at numerous intersections in the impacted area. Calculations using the vehicle data contained in Section 1.2.1 yield an emissions increase (in weighted volume) of +1.7 percent, or a corresponding point score of −3.

AIR POLLUTION SCORE = −3

2.3.2 Noise Impacts of Motor Vehicles

Average sound level readings were taken at many points throughout the proposed Mall area. Present noise levels range from 58 to 66 db(A) without significant vehicle volumes; with autos present the range was from 62 to 68 db(A). Trucks and buses peaked to 86 db(A), and subway air vents were over 90 db(A).

Without trucks and buses, the background will probably be an average of about 62 db(A). However, with bus peaks as indicated, and their frequency, a representative average of about 66 db(A) is being used.

NOISE SCORE $= -10 + [(90 - 66) \times 0.4] = -10 + 9.6 = -0.4$, rounded to 0

2.3.3 Health Effects of Walking

The weather protection afforded by the proposed canopy, relatively low crime rate, and improved appearance of stores and other features are somewhat offset by few (if any) benches and ledges to sit on.

HEALTH SCORE = +2

2.3.4 Conservation of Resources

Low use of direct energy and natural resources with moderate uses of other resources give the facility a relatively good rating.

CONSERVATION SCORE = +5

3.1 Residential Neighborhoods

3.1.1 Residential Dislocation

No known residential dislocation will take place because of the construction of the Mall.

RESIDENTIAL DISLOCATION SCORE = 0

3.1.2 Community Pride, Cohesiveness, and Social Interaction

Strong opinions have been expressed both for and against the proposed Mall. Few of the parameters within this variable are affected by a nonresidential facility location.

COMMUNITY PRIDE AND INTERACTION SCORE = +1

3.1.3 Aesthetic Impact, Compatibility with Neighborhood

Not applicable.

AESTHETICS AND COMPATIBILITY SCORE = 0

3.2 Commercial/Industrial Districts

3.2.1 Gross Retail Sales

A consultant's report prepared for the New York City Economic Development Administration (Perry Meyers, 1973) projected a maximum of two or three additional department stores in downtown Brooklyn by 1980 (independent of the Fulton Mall) with both the new and existing stores accounting for a 56 percent increase in sales over 1972. If one-third of this maximum possible expansion were due to the Mall, and the remainder attributable to other factors, the average annual increase in retail sales for the first two years' operation of the Mall would be about 2 percent.

RETAIL SALES SCORE = +2

3.2.2 Displacement or Renovation Required or Encouraged

DISPLACEMENT OR RENOVATION SCORE = −5

3.2.3 Ease of Deliveries and Employee Commuting

Pickup and deliveries on the Fulton Mall will be prohibited except for those stores which will have severe problems using side-street loading zones (see Fig. B-27). For those stores, special permits will be issued for on-street deliveries between 10:00 a.m. and 7:00 p.m.

On the side streets an additional 1,000 ft of curb space, as recommended by a consultant (Wilbur Smith and Associates, 1973), will be reserved for loading and unloading zones (see Fig. B-27). Side streets have enough capacity to handle the traffic, and work trips will be improved by adding wider sidewalks.

DELIVERIES AND COMMUTING SCORE = +5

3.2.4 Attractiveness of Area to Business

ATTRACTIVENESS TO BUSINESS SCORE = −2

4.1 Transportation and Land Use in the Planning Process

4.1.1 Public Participation in the Planning Process

The Office of Downtown Brooklyn Development is working very closely with the merchants and store owners. A Steering Committee has been formed of Fulton Street

Figure B-27. Truck loading zone off Fulton Street.

merchants, with representation from each block. The committee has direct input on the design of the Mall.
PUBLIC PARTICIPATION SCORE = +4

4.1.2 Conformance with Requirements and Regulations

The facility should comply with all existing codes and regulations. A uniform signing ordinance legislative proposal is currently being prepared.
REQUIREMENTS AND REGULATIONS SCORE = +10

4.2 Economic Impacts

4.2.1 Change in Tax Receipts and Other Government Revenues

Although the Fulton Mall is expected to increase the area's retail sales, these purchases will be diverted from other stores within New York City.
TAX RECEIPTS SCORE = 0

4.2.2 Changes in Employment

EMPLOYMENT SCORE = 6

4.2.3 Change in Cost of Providing Community Services

COMMUNITY SERVICES SCORE = 0

4.3 Community Impacts

4.3.1 Community Activities

Because no significant space in the proposed Mall is devoted to community activities, no changes are estimated.
COMMUNITY ACTIVITIES SCORE = 0

4.3.2 Adaptability to Future Urban Development Plans

The Fulton Mall is an integral portion of the planned revitalization of downtown Brooklyn. In particular, the Mall is symbolic of New York City's future commitment to the people who live and do business in this area.
FUTURE URBAN PLANS SCORE = +10

4.3.3 Construction Period

The construction period is estimated to be two periods of six months each. There will be major disruption of business and pedestrian environment, but lesser negative impacts on transit and pedestrian movement. This is because all vehicles except buses are to be relocated at the start of construction.
CONSTRUCTION SCORE = −7.

Summary

Figure B-28 summarizes the evaluation variable scores for the Fulton Mall.

Name of Project FULTON MALL

Cost initial $10 000 000 annual $350 000 — +271 Total Score

		Variable Score	Variable Weighting	Weighted Score
1.1 Pedestrian Transportation	1.1.1 Travel Time	+2	2.5%	5
	1.1.2 Ease of Walking	+8	3.0	24
	1.1.3 Convenience	+9	3.5	32
	1.1.4 Special Provisions	-2	2.5	-5
1.2 Motor Vehicle Transportation	1.2.1 Vehicle Travel Costs	0	6.0	0
	1.2.2 Use of Automobiles	+1	2.5	3
	1.2.3 Signal/Signing Needs	-5	2.0	-10
1.3 Other Community Transportation	1.3.1 Future Transportation Plans	0	3.0	0
	1.3.2 Existing Transportation	+6	3.0	18
2.1 Safety	2.1.1 Cost of Accidents	+6	12.0	72
	2.1.2 Accident Threat	+8	7.0	56
	2.1.3 Crime Concern	+4	3.0	12
	2.1.4 Emergency	+4	3.5	14
2.2 Attractiveness of Surroundings	2.2.1 Pedestrian Oriented Environment	+1	5.0	5
	2.2.2 Litter Control	-4	1.0	-4
	2.2.3 Density	+4	1.5	6
	2.2.4 Climate Control & Weather Protection	-8	1.5	-12
2.3 Environment/ Health	2.3.1 Air Pollution	-3	3.0	-9
	2.3.2 Noise	0	1.5	0
	2.3.3 Health	+2	1.5	3
	2.3.4 Conservation	+5	1.5	8
3.1 Residential Neighborhoods	3.1.1 Residential Dislocation	0	2.0	0
	3.1.2 Community Pride & Interaction	+1	3.5	4
	3.1.3 Aesthetics & Compatibility	0	3.0	0
3.2 Commercial/ Industrial Districts	3.2.1 Retail Sales	+2	1.5	3
	3.2.2 Displacement or Renovation	-5	1.5	-8
	3.2.3 Deliveries & Commuting	+5	2.0	10
	3.2.4 Attractiveness to Business	-2	2.5	-5
4.1 Planning Process	4.1.1 Public Participation	+4	2.5	10
	4.1.2 Requirements & Regulations	+10	2.0	20
4.2 Economic Impacts	4.2.1 Tax Receipts	0	1.5	0
	4.2.2 Employment	+6	1.0	6
	4.2.3 Community Services	0	1.5	0
4.3 Community Impacts	4.3.1 Community Activities	0	2.5	0
	4.3.2 Future Urban Plans	+10	2.0	20
	4.3.3 Construction	-7	1.0	-7

Figure B-28. Evaluation summary sheet, Fulton Mall, Brooklyn, N.Y.

APPENDIX C

QUESTIONNAIRE ON EVALUATION OF BENEFITS OF PEDESTRIAN FACILITIES

The questionnaire presented in this appendix was devised (a) to determine the practicality of a weighting system reflecting subjective community and decision-maker values and (b) to assist in development of guidelines for use as a starting point in determining representative weights for other communities.

The questionnaire consisted of (a) a cover letter containing a description of the project and a description of the objectives of the questionnaire, (b) instructions on the use of work sheets (with a completed sample) that listed each of the variables to be weighted, (c) a brief description of each of the variables, (d) a summary sheet to be returned to the researchers, and (e) a work sheet for the respondent.

A preliminary version of the questionnaire was distributed to two local agencies (the City of Menlo Park and the California Department of Transportation) for pretesting. After completed questionnaires and comments were received from these two agencies and other reviewers, the questionnaire was revised accordingly and sent to 124 individuals and agencies. A set of four questionnaires each was sent to 13 state highway or transportation agencies by NCHRP, and one questionnaire was sent by SRI to planning departments or other agencies of 93 city governments (65 of which were known to have pedestrian malls) and to 18 other individuals with whom the research team had made contacts.

The state highway and transportation departments were sent questionnaires separately from local agencies, universities, and others because they are members of AASHTO, the sponsors of the research, and because it seemed reasonable to give large state transportation agencies with numerous departments and multiple jurisdictions an opportunity to express several different viewpoints. This separate treatment for state agencies was borne out by the results—14 questionnaires were returned by 9 states (69 percent response rate), whereas only 17 responses were received from other agencies (16 percent response rate). Four questionnaires were not tabulated for various reasons. This was a reasonable response considering that a minimum of several hours was required to complete the questionnaire.

Review of responses to a preliminary version of the questionnaire and discussions with respondents led the researchers to conclude that the weights developed by respondents varied by facility objective. Two types of pedestrian facility were designated by major purpose. The safety/movement type includes those facilities where severe pedestrian/vehicle conflicts occur or where high pedestrian volumes result in congestion, and the primary intent is to provide safe unimpeded pedestrian movement. The social/commercial type includes diverse pedestrian-oriented activities where the major purpose is to provide a safe and enjoyable place for pedestrians to move leisurely and linger, or to shop. Overpasses and pedestrian transit corridors are examples of the first type; malls and small urban parks are examples of the second type.

Responders to the questionnaire were requested to identify which type of facility they were considering, or if both types were being considered together. Ten respondents chose the safety/movement type, 3 chose the social/commercial orientation, and 14 indicated that both types were considered together (combined facilities). An assessment of the responses to the questionnaire is presented in Chapter Two (Findings) of the main report. A copy of the final questionnaire follows.

COVER LETTER

In the AASHTO-sponsored National Cooperative Highway Research Program (NCHRP), Stanford Research Institute is presently conducting Project 20-10, Benefits of Separating Pedestrians and Vehicles, an 18-month study whose objective is to develop a method for evaluating the benefits of pedestrian facilities. The scope includes:

- Identifying the direct and indirect benefits of separation considering transportation, safety, social, economic, environmental, community and health factors.
- Identifying specific population segments likely to benefit from pedestrian-vehicular separation.
- Developing or adapting techniques for measurement of qualitative, quantitative, and dollar values (where possible) for use in the evaluation and design of pedestrian facilities.
- Testing the developed techniques on specific pedestrian facilities.
- Providing suitable documentation for effective use of the results of this research by pedestrian facility planners and engineers.

We have developed four major categories to be evaluated: Transportation, Safety/Environment/Health, Residential/Business, and Government/Institutional. Because the individual benefit factors being considered in this research project cover such a broad range of subject areas, we have selected a weighting system to allow adequate inclusion of the necessarily subjective values of a particular planning or decision-making group.

As a person who plans, evaluates, or designs facilities for pedestrians, we are asking you to participate in an experiment to:

- Examine the practicality of a weighting system evaluation methodology.
- Identify the range of values from a broad selection of analysts, planners, and decision-makers in varying locations.
- Prepare guidelines for other potential users of the evaluation methodology.
- Give you, the participant, an opportunity to try the method, find out how others valued the factors, and provide you with information and a technique that you may find useful in other application areas of your work.

If you are not personally part of the pedestrian facility planning and evaluation process, please pass this questionnaire on to someone who is involved in such activities.

We have identified two types of pedestrian facilities based on their major purpose. The safety/movement type includes those facilities where severe pedestrian/vehicle conflicts occur or where high pedestrian volumes result in congestion, and the primary intent is to provide safe unimpeded pedestrian movement. The social/commercial type includes those pedestrianization facilities where the major purpose is to provide a safe and enjoyable place for pedestrians to move leisurely and stop. Overpasses are examples of the first type, and malls are typical examples of the second type.

We made this differentiation because of response variations and suggestions received during the pretest period for this questionnaire. We are interested in obtaining your personal values for either or both of these types of facilities. Please indicate on the Result Sheet (Figure 3) the type considered when you complete the questionnaire.

The object of this questionnaire is to identify your perception of the desired relative importance of changes in various benefit factor groupings for your community. Please do not attempt to measure the factor values based on a specific existing or planned pedestrian facility; instead develop values indicating your own preferences.

A brief explanation and forms to use are attached. The returns will be coded but all personal identification will be removed for processing and publication of results. If you have any questions or comments that you would like to address to us, write or call Ron Braun or Marc Roddin (collect) at area code 415, 326-6200. A pre-addressed label is enclosed for your convenience in returning the questionnaire to us.

Your contribution to this project will be greatly appreciated and will be reflected in the quality and usefulness of our final product to you. Thank you.

INSTRUCTIONS

The object of this experiment is to determine your perception of the relative importance of changes in various benefit factor groupings for your community. The end result will be a set of values expressed in percentages for each of the three levels of factor categories, the sum of each level being 100% (illustrated in Figure 1, three left-hand columns). The product of the percentage values of each level assigned by the evaluators and/or decision makers (illustrated by the right-hand column in Figure 1) thereby indicates the relative importance of each individual factor in the total evaluation process. For example, the 2.4% rating for "Travel Time" was arrived at by taking the product of the percentage values of each of the related headings: 20%--Transportation (main-head), 40%--Pedestrians (sub-head), 30%--Travel Time (subset), and multiplying (.2 x .4 x .3 = .024 = 2.4%).

When these weights are multiplied by a measurement for each individual factor (e.g., privacy) on a uniform scale such as -10 to +10 for each facility proposal being considered, a consistent methodology is available to evaluate proposed facilities and alternatives for a given community.

The following procedure is suggested to assist you in developing your set of relative values:

1. Remove Figure 4 (last page) which is a work sheet similar to Figure 1 for your use in assigning a set of values as described above.
2. Refer to Figure 2 (a narrative) to familiarize yourself with the categories and descriptions of the factors as listed on the work sheet (Figure 4).
3. Rank order (1, 2, 3, etc.) each subset of categories or factors. First rank order the major categories, then the smaller categories within each major category, and finally each subset of individual factors. This may be easier than attempting to assign actual percentage values on the first attempt.
4. Repeat step 3 refining the rank ordering into percentages as illustrated in Figure 1. Zero is a legitimate percentage value to use at any level (e.g., Signal/Signing Needs Adjacent to Facility in Figure 1).
5. Review your assigned weights and revise them if desired. You may wish to multiply the three level weights together to determine and compare the resulting relative weight of each individual factor.
6. Transfer your results to Figure 3 (Result Sheet), write any comments that you feel may be useful to us on the provided page, and return the Result Sheet and Comment Page to us. You may keep the Work Sheet (Figure 4) for your records.

Figure 1

SAMPLE VALUES

Types of Facilities Being Evaluated
[X] Safety/Movement Only
[ ] Social/Commercial Only
[ ] Both Types Together

Rank Order / Percent-Ages				Levels of Evaluation Factors	Weight of Each Factor (Optional)
2 /20%	I.			Transportation	
		1 /40%		Pedestrians	
			1 /30%	Travel Time	2.4 %
			4 /20%	Ease of Walking	1.6
			3 /20%	Convenience (Access and Availability)	1.6
			2 /30%	Special Provision for Various Groups	2.4
			(100%)		
		2 /40%		Motor Vehicles	
			1 /90%	Motor Vehicle Travel Costs	7.2
			2 /10%	Use of Automobiles	.8
			3 / 0%	Signal/Signing Needs Adjacent to Facility	0
			(100%)		
		3 /20%		Other Community Transportation	
			1 /80%	Adaptability to Future Transportation Development Plans	3.2
			2 /20%	Impact on Use of Other Transportation Systems	.8
		(100%)	(100%)		
1 /60%	II.			Safety/Environment/Health	
		1 /80%		Safety	
			1 /70%	Societal Cost of Accidents	33.6
			2 /10%	Accident Threat Concern	4.8
			3 /10%	Crime	4.8
			4 /10%	Emergency Access/Medical and Fire Facilities	4.8
			(100%)		
		3 /10%		Attractiveness of Surroundings	
			2 /30%	Pedestrian Oriented Environment	1.8
			4 /10%	Litter Control	.6
			1 /40%	Density	2.4
			3 /20%	Climate Control and Weather Protection	1.2
			(100%)		
		2 /10%		Environment/Health	
			5 /10%	Property Damage Effects of Air Pollution	.6
			1 /40%	Health, Psychological and Other Effects of Air Pollution	2.4
			3 /30%	Noise Impacts of Motor Vehicles	1.8
			2 /10%	Health Effects of Walking (exercise, fatigue, etc.)	.6
			4 /10%	Conservation of Resources	.6
		(100%)	(100%)		
3 /10%	III.			Residential/Business	
		1 /50%		Residential Neighborhoods	
			2 /20%	Residential Dislocation	1.0
			3 /30%	Community Pride, Cohesiveness, and Social Interaction	1.5
			1 /50%	Aesthetic Impact, Compatibility with Neighborhood	2.5
			(100%)		
		2 /50%		Commercial/Industrial Districts	
			2 /20%	Displacement, Replacement, or Renovation	1.0
			1 /50%	Profit After Taxes	2.5
			4 /10%	Ease of Deliveries and Employee Commuting	.5
			3 /20%	Attractiveness of Area to Business	1.0
	3	(100%)	(100%)		
4 /10%	IV.			Government/Institutional	
		2 /20%		Planning Process	
			1 /60%	Transportation and Land Use Planning Process	1.2
			2 /40%	Conformance with Requirements and Regulations	.8
			(100%)		
		3 /10%		Indirect Impacts	
			1 /80%	Net Change in Tax Receipts and Other Revenue	.8
			2 /20%	Resulting Changes in Employment	.2
			(100%)		
		1 /70%		Community Impacts	
			1 /60%	Community Activities	4.2
			2 /20%	Change in Cost of Providing Community Services	1.4
			3 /20%	Adaptibility to Future Urban Development Plans	1.4
(100%)		(100%)	(100%)		(100%)

Figure 2

Descriptions of Factors to be Measured in Assessing the Benefits of Pedestrian and Vehicle Separation Facilities

Four major categories of factors were selected to organize the total impact of pedestrian and vehicle separation facilities in a selected evaluation area. Each category represents a convenient and logical grouping of generally related individual factors. The four major categories are:

1. Transportation--includes the transportation impacts on actual and potential users of all transportation facilities within the evaluation area.

2. Safety/Environment/Health--includes the safety and health impacts of the facilities under study on all persons within the evaluation area (both users and nonusers); the attractiveness of the facility to pedestrians; also the impacts of pollution on property and the physical environment.

3. Residential/Business--includes the impacts on personal property, personal attitudes and interpersonal relationships of residents and guests within the evaluation area; also the impacts on industrial and commercial properties, retail sales and transactions within the evaluation area as a result of the facilities under study.

4. Government/Institutional--includes the impacts of the facility under study on government and community-wide services and activities.

The list which follows describes all of the individual factors to be considered under each of the four categories outlined above. The selection of individual factors was guided by the following criteria:

1. Include all social, environmental, and economic factors that may contribute significant benefits or disbenefits as a result of the construction of a large scale facility such as a pedestrian mall, recognizing that evaluation of smaller facilities such as a pedestrian overpass may require only a small subset of these impacts.

2. Select factors that can be reasonably described and understood whether or not generally accepted measurement techniques are available to determine the degree of impact. One objective of the study is to identify and extend the state-of-the-art in measurement techniques for a broad range of potential impacts.

3. Select and define factors so that each one is independent of all other factors to the greatest extent possible. This is essential to producing a reasonably accurate and acceptable evaluation methodology. Clearly, it is not always possible to achieve complete independence of impacts, particularly when secondary effects are considered. However, we feel that the factors to be described closely meet the outlined criteria.

A special point must be made about changes in land and property values (both residential and commercial) as a result of a separation facility. A long list of factors underlie the value of property and land. They include the location of the property, supply and demand, transition trends, substitution availability, highest and best use, conformity of use, anticipation of future benefits and uses, the economic base of the area, the time of purchase, use controls and improvement factors. All of these may be boiled down to the needs and desires of the buyer and the seller operating in the real estate marketplace. The extensiveness of our evaluation factor categories is such that these values are incorporated in other factors. Thus estimating changes in property values would double count values already included.

In a perfect marketplace, property value would rise or fall to reflect the total benefits or disbenefits of community modification including separation facilities. Unfortunately, estimating the direction and magnitude of such changes requires a knowledge of each of the underlying factors contributing to property values, or an accurate comparison with similar properties in different communities--a near impossible task. By estimating the value of each underlying factor and thereby determining the net benefit or disbenefit impact of a facility, we are predicting the ideal net increase or decrease in total property value. For these reasons, land and property value changes will not be directly estimated in determining benefits of separation facilities.

The following list of definitions briefly describes each of the individual factors within the four major categories:

I. Transportation

Pedestrian Impacts

Travel Time--Changes in travel time are dependent on route length and walking rate; travel time measurements reflect effects of delays due to barriers or crowding, walking surfaces and grade changes; travel time valuation reflects trip purpose and other individual parameters. Care will be taken in evaluating travel time to exclude elements of personal comfort and convenience since they are valued separately as indicated below.

Ease of Walking--Includes walking surface; grade change; path continuity; signing (information, direction, assurance, confirmation); lighting adequacy.

Convenience--Factors related to access and availability will be addressed; time facility is open for use and access to alternative transportation modes, alternative destinations and routes, and community facilities (schools and education centers, parks and recreation facilities, historical and cultural sites, doctors' offices, clinics and hospitals, places of worship, and retail stores).

Special Provisions for Various Groups--Measurement indices will be developed or adapted to value the ability of each facility to meet the special needs of such groups as young children, mobility limited and other handicapped, bicyclists, joggers, strollers, visitors, shoppers.

Motor Vehicle Impacts

Motor Vehicle Travel Costs--Effects of facilities on vehicle operating costs (fuel, oil, tires, maintenance and repairs) for specific trips will be assessed--these effects may be either benefits due to improved flow and fewer stops, or disbenefits due to increased route lengths and increased congestion; travel time changes for vehicle occupants will also be assessed as well as changes in parking costs.

Use of Automobiles--Changes in numbers of automobile trips, or reductions in automobile ownership (unlikely except for very large pedestrian networks) will be assessed; the resulting changes in operating costs and vehicle value will be included in benefit assessments; time saved by fewer trips may be offset by greater walking times than comparable vehicle trip times depending on the time of day.

Signal/Signing Needs Adjacent to Facility--Changes in signals and signing on adjacent streets and transit routes to direct and control traffic will be assessed.

Other Community Transportation

This factor is included to assess the impact of the facility on community transportation systems other than automobiles and pedestrians. Consistency with future transit, highway, and bikeway plans and impact on use of other modes of transportation are considered.

II. Safety/Environment/Health

Safety

Societal Cost of Accidents--Reductions in accident losses will be estimated based on past accident experience at the site or other representative experience. Included are medical costs, legal and court costs, property damage (usually slight), insurance overhead, payments to survivors, loss of earnings, etc.

Accident Threat Concern--Perception of danger from pedestrian/vehicular conflicts (including bicycles) will be estimated.

Crime--Impact of proposed police patrol services must be estimated; large scale pedestrian facilities are frequently associated with shopping areas and multifamily dwellings, and service calls to these areas frequently increase by significant percentages. Increased police patrols may be required to maintain acceptable citizen protection.

Emergency Access/Medical and Fire Facilities--An assessment of the adequacy of plans and available routes for providing police, fire, and medical services in emergency situations; also availability of emergency telephones, first aid materials, fire extinguishers, etc.

Attractiveness of Surroundings

Pedestrian Oriented Environment--Positive impacts of amenities, the arts, buildings, communications, outdoor eating, exhibits, nature, physical comfort, retail outlets, and fountains will be assessed; negative visible impacts such as caged overpasses, utility wires, extensive parking areas, and vacant walls or lots will be subtracted from the positive scores.

Litter Control--The cleanliness of the facility will be evaluated on a scale that ranges from clean to heavily littered, based on comparison with photographs of street and alley litter conditions; existence of trash baskets, antilitter laws and their enforcement, and public education against littering are also assessed.

Density--The available walking area per person, which indicates both activity and walking conflicts, will be evaluated on a scale that ranges from empty, through impeded and constrained, to numerous conflicts and measurable delay.

Climate Control and Weather Protection--The adequacy of heating, air conditioning, and ventilation for indoor facilities is assessed; shielding from sun, wind, and precipitation is also evaluated.

Health/Environment

Property Damage Effects of Air Pollution--An estimate will be made of changes in property and plant life damages averted or caused by changes in air pollution resulting from the facility under study. Because the most serious air pollution impacts occur near the polluting source, seemingly small changes may have significant results; for example, if an overpass near a school eliminated a vehicle stop on a heavily traveled roadway, a significant reduction in air pollution may result at that location if the traffic volume does not increase.

Health, Psychological, and Other Effects of Pollution--Estimates of changes in concentration levels of carbon monoxide, hydro carbons, nitrogen oxides, lead and sulphur compounds will be compared with presently available health impact data and other measures to obtain estimated values for reduction or increase in air contaminants resulting from the facility under study; the impact of personal attitudes and reactions to odors, affected visibility, and perceived health effects will also be estimated; both local and community-wide impacts will be assessed.

Noise Impacts--Estimates will be made of changes in sound levels resulting from the facility; these changes will be compared with effects of sound levels on conversation and other activities.

Health Effects of Walking--The generally accepted benefits of walking will be estimated but will be offset by adverse health impacts of fatigue and over-exertion by some groups of users, such as elderly and handicapped.

Conservation of Resources--Resource utilization will be used to estimate the impact of construction, use and maintenance on available resource materials such as land, energy, materials, water, and others; this measure will reflect desire to preserve resources rather than estimating the dollar value of resources saved or consumed, such as gasoline saved by fewer auto trips which is counted in motor vehicle impacts.

III. Residential/Business

Residential Neighborhoods

Residential Dislocation--Unreimbursed relocation costs will be counted as disbenefits; in addition, loss of use, access, interpersonal associations that are not adequately reimbursed will also be estimated as disbenefits;

reclamation or improvements to previously unused areas will be considered as benefits.

Residential Land Value Changes--As explained on page 6, land value changes essentially reflect changes in desirability and acceptability on the part of the buyers and sellers; thus the combination of residential and business property values ideally represent or reflect the sum of all benefits and disbenefits of a separation facility; as noted earlier, land and property value changes will not be included in the benefit evaluation procedure to avoid double counting of benefit values.

Community Pride, Cohesiveness, and Social Interaction--
The impact of pedestrian facilities on interpersonal relationships within the community in terms of community self image and neighborhood ties; voluntary improvement to, or degradation of, personal and community property is a potential indicator of changes in community attitudes and self evaluation.

Aesthetic Impact, Compatability with Neighborhood--Criteria will be developed to assist in assessing the probable personal reaction to the design attractiveness of the facility, and the way that it fits in with the character of the neighborhood.

Commercial/Industrial Districts

Displacement, Replacement, or Renovation Required or Encouraged by Facility--Unreimbursed relocation or renovation costs must be considered; some of these costs, such as improvements to stimulate business, will be recovered later but their initial cost must still be considered a disbenefit; increased sales are separately itemized.

Profit After Taxes--Changes in net profits after taxes may result from improved customer access, improved attractiveness of individual stores or the general area, changes in tourism possibly generated by the facility, or changes in store occupancy due to improved location desirability.

Ease of Deliveries and Employee Commuting--Benefits or disbenefits of changes in access for employees, deliveries and business contacts due to facility design will be assessed.

Attractiveness of Area to Business--Estimates of the intangible benefits or disbenefits of doing business (pleasant atmosphere, favorable attitudes towards business, etc.) at or near the separation facility exclusive of values due to changes in profits will be assessed.

IV. Government and Institutional

Planning Process

Transportation and Land Use Planning Process--Public input and interaction in the transportation and land use planning process will be assessed and changes due to the facility planning process will be estimated; cooperation between public and private planners will also be assessed.

Conformance with Requirements and Regulations--An assessment will be made of the adequacy of compliance of the facility with building codes and zoning ordinances; the benefits and disbenefits of permanent changes; and permitted exceptions to regulations will also be noted or and assessed.

Indirect Impacts

Net Change in Tax Receipts and Other Revenues--When business activities such as retail sales are or will be affected by a facility under study, changes in tax revenues will be assessed (only after-tax profits were included above to avoid double counting; net property tax revenues will be assessed, as will changes in fines and administtative costs associated with pedestrian and vehicle violations.

Resulting Changes in Employment--The benefits or disbenefits of changes in employment that may result from an extensive pedestrian separation facility will be estimated; care will be taken to exclude previously valued factors of employment changes such as sales increases and changes in cost of providing community services.

Community Impacts

Changes in Community Activities--Evidence of changes in overall community values may be assessed from participation and attendance at special events, plays and concerts, exhibits and displays, voter turnout and other public activities.

Change in Cost of Providing Community Services—Changes in demand for community services may result from separation facilities if access is improved or if basic community attitudes and opinions change.

Adaptability to Future Urban Development Plans--Consistency with future urban development plans, and possible impacts on them, will be considered.

Types of Facilities Being Evaluated

- [ ] Safety/Movement Only
- [ ] Social/Commercial Only
- [ ] Both Types Together

Figure 3

RESULT SHEET

Percent-Ages | Levels of Evaluation Factors

____ % I. Transportation

- ____ % Pedestrians
  - ____ % Travel Time
  - ____ % Ease of Walking
  - ____ % Convenience (Access and Availability)
  - ____ % Special Provision for Various Groups
  - (100%)
- ____ % Motor Vehicles
  - ____ % Motor Vehicle Travel Costs
  - ____ % Use of Automobiles
  - ____ % Signal/Signing Needs Adjacent to Facility
  - (100%)
- ____ % Other Community Transportation
  - ____ % Adaptability to Future Transportation Development Plans
  - ____ % Impact on Use of Other Transportation Systems
  - (100%)
- (100%)

____ % II. Safety/Environment/Health

- ____ % Safety
  - ____ % Societal Cost of Accidents
  - ____ % Accident Threat Concern
  - ____ % Crime
  - ____ % Emergency Access/Medical and Fire Facilities
  - (100%)
- ____ % Attractiveness of Surroundings
  - ____ % Pedestrian Oriented Environment
  - ____ % Litter Control
  - ____ % Density
  - ____ % Climate Control and Weather Protection
  - (100%)
- ____ % Environment/Health
  - ____ % Property Damage Effects of Air Pollution
  - ____ % Health, Psychological and Other Effects of Air Pollution
  - ____ % Noise Impacts of Motor Vehicles
  - ____ % Health Effects of Walking (exercise, fatigue, etc.)
  - ____ % Conservation of Resources
  - (100%)
- (100%)

____ % III. Residential/Business

- ____ % Residential Neighborhoods
  - ____ % Residential Dislocation
  - ____ % Community Pride, Cohesiveness, and Social Interaction
  - ____ % Aesthetic Impact, Compatibility with Neighborhood
  - (100%)
- ____ % Commercial/Industrial Districts
  - ____ % Displacement, Replacement, or Renovation
  - ____ % Profit After Taxes
  - ____ % Ease of Deliveries and Employee Commuting
  - ____ % Attractiveness of Area to Business
  - (100%)
- 3 (100%)

____ % IV. Government/Institutional

- ____ % Planning Process
  - ____ % Transportation and Land Use Planning Process
  - ____ % Conformance with Requirements and Regulations
  - (100%)
- ____ % Indirect Impacts
  - ____ % Net Change in Tax Receipts and Other Revenue
  - ____ % Resulting Changes in Employment
  - (100%)
- ____ % Community Impacts
  - ____ % Community Activities
  - ____ % Change in Cost of Providing Community Services
  - ____ % Adaptibility to Future Urban Development Plans
  - (100%)
- (100%)

(100%)

COMMENT PAGE

Please check off the types of existing or planned pedestrian facilities within your community:

- [ ] malls
- [ ] skyways
- [ ] sidewalks
- [ ] overpasses
- [ ] grade-separated networks
- [ ] signalization
- [ ] underpasses
- [ ] barriers
- [ ] crosswalks
- [ ] other ________________(please specify)

THE REMAINDER OF THIS PAGE IS RESERVED
FOR ANY COMMENTS YOU MAY WISH
TO MAKE TO THE RESEARCHERS

Types of Facilities Being Evaluated

- [ ] Safety/Movement Only
- [ ] Social/Commercial Only
- [ ] Both Types Together

Figure 4

WORK SHEET

Rank Order / Percent-Ages — Levels of Evaluation Factors — Weight of Each Factor (Optional)

___/___% I. Transportation

  ___/___% Pedestrians

    ___/___% Travel Time ______%
    ___/___% Ease of Walking ______
    ___/___% Convenience (Access and Availability) ______
    ___/___% Special Provision for Various Groups ______
    (100%)

  ___/___% Motor Vehicles

    ___/___% Motor Vehicle Travel Costs ______
    ___/___% Use of Automobiles ______
    ___/___% Signal/Signing Needs Adjacent to Facility ______
    (100%)

  ___/___% Other Community Transportation

    ___/___% Adaptability to Future Transportation Development Plans ______
    ___/___% Impact on Use of Other Transportation Systems ______
  (100%) (100%)

___/___% II. Safety/Environment/Health

  ___/___% Safety

    ___/___% Societal Cost of Accidents ______
    ___/___% Accident Threat Concern ______
    ___/___% Crime ______
    ___/___% Emergency Access/Medical and Fire Facilities ______
    (100%)

  ___/___% Attractiveness of Surroundings

    ___/___% Pedestrian Oriented Environment ______
    ___/___% Litter Control ______
    ___/___% Density ______
    ___/___% Climate Control and Weather Protection ______
    (100%)

  ___/___% Environment/Health

    ___/___% Property Damage Effects of Air Pollution ______
    ___/___% Health, Psychological and Other Effects of Air Pollution ______
    ___/___% Noise Impacts of Motor Vehicles ______
    ___/___% Health Effects of Walking (exercise, fatigue, etc.) ______
    ___/___% Conservation of Resources ______
  (100%) (100%)

___/___% III. Residential/Business

  ___/___% Residential Neighborhoods

    ___/___% Residential Dislocation ______
    ___/___% Community Pride, Cohesiveness, and Social Interaction ______
    ___/___% Aesthetic Impact, Compatibility with Neighborhood ______
    (100%)

  ___/___% Commercial/Industrial Districts

    ___/___% Displacement, Replacement, or Renovation ______
    ___/___% Profit After Taxes ______
    ___/___% Ease of Deliveries and Employee Commuting ______
    ___/___% Attractiveness of Area to Business ______
3 (100%) (100%)

___/___% IV. Government/Institutional

  ___/___% Planning Process

    ___/___% Transportation and Land Use Planning Process ______
    ___/___% Conformance with Requirements and Regulations ______
    (100%)

  ___/___% Indirect Impacts

    ___/___% Net Change in Tax Receipts and Other Revenue ______
    ___/___% Resulting Changes in Employment ______
    (100%)

  ___/___% Community Impacts

    ___/___% Community Activities ______
    ___/___% Change in Cost of Providing Community Services ______
    ___/___% Adaptibility to Future Urban Development Plans ______

(100%) (100%) (100%) (100%)

THE TRANSPORTATION RESEARCH BOARD is an agency of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's purpose is to stimulate research concerning the nature and performance of transportation systems, to disseminate information that the research produces, and to encourage the application of appropriate research findings. The Board's program is carried out by more than 150 committees and task forces composed of more than 1,800 administrators, engineers, social scientists, and educators who serve without compensation. The program is supported by state transportation and highway departments, the U.S. Department of Transportation, and other organizations interested in the development of transportation.

The Transportation Research Board operates within the Commission on Sociotechnical Systems of the National Research Council. The Council was organized in 1916 at the request of President Woodrow Wilson as an agency of the National Academy of Sciences to enable the broad community of scientists and engineers to associate their efforts with those of the Academy membership. Members of the Council are appointed by the president of the Academy and are drawn from academic, industrial, and governmental organizations throughout the United States.

The National Academy of Sciences was established by a congressional act of incorporation signed by President Abraham Lincoln on March 3, 1863, to further science and its use for the general welfare by bringing together the most qualified individuals to deal with scientific and technological problems of broad significance. It is a private, honorary organization of more than 1,000 scientists elected on the basis of outstanding contributions to knowledge and is supported by private and public funds. Under the terms of its congressional charter, the Academy is called upon to act as an official—yet independent—advisor to the federal government in any matter of science and technology, although it is not a government agency and its activities are not limited to those on behalf of the government.

To share in the tasks of furthering science and engineering and of advising the federal government, the National Academy of Engineering was established on December 5, 1964, under the authority of the act of incorporation of the National Academy of Sciences. Its advisory activities are closely coordinated with those of the National Academy of Sciences, but it is independent and autonomous in its organization and election of members.

TRANSPORTATION RESEARCH BOARD

National Research Council
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Washington, D.C. 20418

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