

METREK DIVISION

Policing Urban Mass Transit Systems:
Evaluation Designs and Recommendations
for future Research

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MAY 1977

60283¹²

MITRAE

MITRE Technical Report
MTR-7559

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NCJRS

AUG 3 1979

CONTRACT SPONSOR	NILECJ/LEAA
CONTRACT NO.	76-NI-99-0111
PROJECT NO.	2480
DEPT.	W-26

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ABSTRACT

This report presents seven recommendations concerning promising areas for future research in the policing of urban mass transit systems and offers a general design for evaluating transit policing activities. The evaluation design identifies measures needed to assess outcome objectives, delineates data elements required for evaluation, examines several alternative research designs and discusses various aspects of data analysis.

PREFACE

The "Policing Urban Mass Transit Systems" study is one in a series of National Evaluation Program (NEP) Phase I studies initiated by the National Institute of Law Enforcement and Criminal Justice. The NEP program involves the selection of major areas of criminal justice activities that are of national importance and the funding of research studies to provide a timely and an objective assessment of the effectiveness of alternative strategies or programs in each selected topic area. Some of the specific topic areas examined under the NEP program thus far have included: pre-trial release, treatment of drug addicts coming into contact with the criminal justice system (TASC), Project Ident (marking of personal properties), juvenile diversion, court information systems, and anti-robbery projects.

This National Evaluation Program Phase I study focuses on policing responses to crimes on urban mass transit systems and assesses the adequacy of current knowledge about their effectiveness and cost in controlling crime and increasing public perceptions of security. As with other NEP Phase I studies, this transit policing study consists of six stages:

- review of the existing literature and work in progress and delineation of issues;
- description of existing project operations;
- formulation of analytical framework or model(s) for synthesizing information and understanding project types;
- assessment of what is currently known and what additional evaluation activity is warranted;
- design of an evaluation, based on the previously developed analytical model, for the overall program; and
- design of an evaluation of individual projects.

This report, the product of the fifth and sixth stages, presents recommendations for future research oriented toward responding to current problems and acquiring additional knowledge and suggests a general design for evaluating these activities. Section I provides an overview of the recommendations, examining the basic problem, scope of the suggested effort, and practical benefits that may be achieved. Section II outlines a general research design that may be used to evaluate urban mass transit system policing activities. This section reviews transit policing operations and the need to evaluate

these activities, identifies measures needed to assess outcome objectives, lists data elements required for evaluation, outlines several research designs, and addresses many aspects of data analysis. Finally, an evaluation design for a proposed case study of policing on the Washington Metropolitan Area Transit Authority is presented in Section III.

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SECTION I

AN OVERVIEW OF RECOMMENDATIONS

An earlier report,¹ assessing what is presently known about crime and policing in urban mass transit systems, presents seven programmatic and/or research-oriented recommendations. The recommendations are designed to respond to current transit crime problems and acquire more and better knowledge. The crime-control recommendations include:

- develop and evaluate projects directed toward controlling juvenile crime;
- improve mechanical and electronic security-related equipment; and
- improve fire prevention and detection capabilities.

The knowledge-oriented recommendations include:

- evaluate the effects and effectiveness of specific security strategies;
- develop and implement uniform crime reporting for transit systems;
- develop a handbook for passenger perception measurement; and
- initiate a case study of policing the Washington Metropolitan Area Transit Authority.

The recommendations are outlined below. The discussion of each recommendation includes three basic components:

- defining the basic problems to be addressed;
- outlining the scope of the suggested programmatic and/or research effort; and

¹Siegel, L. G., M. J. Molof, W. S. L. Moy, J. R. Strack and F. C. Jordan, Jr., An Assessment of Crime and Policing Responses In Urban Mass Transit Systems, MTR-7497, The MITRE Corporation/METREK Division, April 1977.

- delineating practical benefits that may be realized by government administrators, transit authority officials, transit police and, in the long run, the riding public.

A. Develop and Evaluate Projects Directed Toward Controlling Juvenile Crime

Profiles of mass transit criminals indicate that a significant number of offenders are juveniles. Transit police in a number of cities including Baltimore, Los Angeles, Philadelphia and San Francisco state that juveniles are a major, if not the primary, source of transit-related criminal incidents. A few transit systems have had some success with school trippers (specially designated buses for transporting students to and from school), school programs emphasizing the vital service provided to the community by mass transit, and increased police patrol. However, juvenile-related crime remains a serious transit problem.

This suggests a need to develop and evaluate projects directed toward controlling juvenile crime on transit systems. One project could consist of implementing and evaluating presently used strategies in a number of cities to assess effectiveness and determine potential transferability. Another possible project could involve the creation of a juvenile unit staffed with civilian specialists including counselors and youth workers. Such a unit could be based on similar units operational in a number of city police departments. Still another possible project could be based on the concept of restitution and on close cooperation between the courts and transit police. Juveniles convicted of transit-related crimes would be referred by the court to the juvenile unit. In turn, the juvenile unit would supervise offenders, providing counseling and overseeing work oriented toward cleaning up the transit environment, removing graffiti and other signs of vandalism.

B. Improvement of Mechanical and Electronic Security-Related Equipment

A number of problems have surfaced in this area. The use of counterfeit coins and tokens to gain access to rapid rail transit is growing in the large and older systems. Closed-circuit television (CCTV) often is poorly integrated with other security activities. Automatic coin-change and ticket vending machines frequently are unreliable and vulnerable to vandalism and theft.

In this context, transit company officials, police and researchers see a need for the following types of improvements:

- developing fare collection equipment to detect the use of slugs;
- hardening automatic coin-change and ticket vending machines;
- improving the capability of CCTV surveillance equipment and integrating the use of this equipment with transit police operational requirements; and
- improving multiple-channel radio communication capability in subways to facilitate the coordination and control of operations involving general city police, transit police, fire and rescue units.

Equipment-oriented research also should be directed toward improving reliability while reducing maintenance and cost. Design and operational factors must incorporate features to facilitate public acceptance (e.g., automatic fare collection equipment that is easy to use) and accommodate a wide variety of environmental conditions such as dampness and ambient noise.

There are a host of practical benefits that may be gained from these research efforts. Improvement of CCTV capabilities could, in many instances, reduce the need for fixed patrol posts and lead to collection of better evidence resulting in clearer identification of criminal suspects. Similarly, improvement of multiple-channel radio communication capabilities could contain disasters, thus saving lives and reducing financial loss.

Additionally, research is needed to analyze human engineering problems associated with extensive use of CCTV equipment. For example, transit crime exhibits a bimodal frequency distribution, peaking during morning and evening rush hours; if people monitoring CCTV cameras finish their eight-hour shift at the end of the evening rush hour, fatigue may reduce potential surveillance and anti-crime capabilities of CCTV. Research would provide information concerning the scheduling of monitor shifts (e.g., shifts starting at the beginning of rush hours or limiting shifts to four hours) and possibly enhance the effectiveness of CCTV.

C. Improvement of Fire Prevention and Detection Capabilities

Acts of arson pose serious threats to passengers and transit properties, although only isolated incidents have been reported thus

far. In 1976, a fire set on board a subway train caused two to three million dollars in damage in the Toronto system. A similar incident occurred in Oakland (BART), resulting in \$200,000 to \$300,000 worth of damage to subway cars. Prevention and early detection capabilities need to be developed for subway trains to fight against arson.

Like other security-related equipment, fire prevention and detection devices must be designed with reliability, maintenance and cost in mind. The equipment should be thoroughly tested in an experimental environment to ensure sufficiently high levels of reliability and low levels of maintenance. Further, the equipment must be designed to function in all types of environmental conditions. Potential benefits include averting major disasters, saving lives and eliminating financial losses.

D. Evaluation of the Effects and Effectiveness of Specific Security Strategies

Transit police often employ different strategies to counter similar crime problems. For example, several police chiefs rely on preventive patrol to deter potential robbers. Other transit police chiefs believe that preventive patrol merely pushes crime away from targeted areas and, for that reason, apprehension-oriented police activities are essential to reduce crime; hence, they have combined preventive patrol with decoy activities. Similarly, some bus systems depend on police riding patrols to protect drivers and passengers from robberies and assaults, while other systems rely on silent alarms and 2-way radios.

Other strategies commonly used by transit police but thus far not evaluated in terms of effectiveness and cost include mobile patrols, fixed posts, stakeouts, and decoys. An examination of any of these strategies should be conducted within the context of a quasi-experimental or experimental design. Analyses and comparisons across several transit system would provide a basis for determining generalizability of findings.

Formal evaluations of specific security activities can provide decision-makers with valuable information concerning the effectiveness of various strategies. Examined within the perspective of the nature and extent of the problem and resources available, evaluations can address key questions such as the long-term allocation of scarce resources, the short-term selection of tactical responses to changes in criminal activity, and the potential transferability of specific strategies as well as the need to modify current activities and develop innovative approaches to transit policing.

E. Develop and Implement Uniform Crime Reporting for Transit Systems

There are a variety of crime classification schemes in use. Some police departments group criminal incidents into the three following categories:

- violent crime against persons;
- offenses against personal property; and
- offenses against system property.

Other transit police units classify crime according to "who," "when," and "where." Moreover, definitions of what constitutes various criminal acts vary among departments.

These differences complicate comparisons between systems in terms of crime levels and problems and also preclude aggregation of data (at several points in time) needed to determine national transit-related crime trends. Development and implementation of a uniform crime reporting format for transit systems would normalize definitions, standardize information collected for each crime type and provide a meaningful data base for across-system evaluations.

F. Develop Handbook for Passenger Perception Measurement

Passenger perceptions of transit crime and security provide important outcome measures of policing operations. To date, passenger perceptions have been the primary subject of about half-a-dozen studies and a secondary concern of several other research efforts. Unfortunately, these studies differ significantly in the populations tapped, sampling strategies, type of questions, methods of data collection and analyses techniques. Further, many of the studies are poorly designed. Such methodological problems undermine confidence in the findings and inhibit meaningful comparisons across these studies.

Development of a passenger perception measurement handbook for transit authorities would go a long way toward solving these problems. The handbook should contain guidelines for the administration and interpretation of passenger perception surveys, sampling strategies, sample data collection forms, and appropriate analyses frameworks. Such a handbook would provide transit systems with a methodology for systematically assessing passenger perceptions of transit crime and security and a means of evaluating security activities. Widespread use of the handbook also would promote comparability of findings among transit systems.

G. Case Study of Policing the Washington Metropolitan Area
Transit Authority (WMATA)

The Washington, D. C. rapid rail transit system provides a unique opportunity for a case study. WMATA, which initiated passenger services at the end of March 1976 on a limited basis, will expand operations in planned phases over the next several years. This presents a situation where the rapid rail transit system will continue to expand while the police force will remain relatively constant in terms of manpower and equipment. A case study of WMATA over the next several years can provide information concerning the effects of substantial changes in system parameters on policing operations and effectiveness. Data collected during the case study also can be used to discern the development of crime patterns, assess the responses of the police unit, document the relations between WMATA and local police departments in terms of cooperation and conflict, and investigate the impact of both crime and policing on passenger perceptions of security and the use of the transit system. Information gained from this study would be valuable for new rapid rail transit systems currently in the planning/building stages.

Implementation of any of the above recommendations, either locally by individual transit properties or nationally via a demonstration program, should be accompanied by careful documentation and evaluation. Section II discusses the general components of a formal evaluation of urban mass transit policing activities, including outcome measures, data elements, research designs and data analyses. A slightly different type of evaluation approach for the case study of the Washington Metropolitan Area Transit Authority is presented in Section III.

SECTION II

A GENERAL DESIGN FOR EVALUATING URBAN MASS TRANSIT SYSTEM SECURITY PROGRAMS

A. Transit Security Operations

The evaluation of policing activities on urban transit systems must take into account the differences in the scope and nature of the work performed by various transit police units. Some transit police units are responsible solely for passenger and employee security. Other units, in addition, are charged with the protection of transit property and revenues, the provision of emergency services (fire fighting, first aid, rescue), and the performance of non-law enforcement duties (lost and found, public information).

To fulfill these responsibilities, transit police utilize a wide range of activities. Some transit police units employ traditional patrol activities while others augment overt patrol with stakeout teams, decoys and mechanical/electronic communication and surveillance devices. Still other transit police departments emphasize community relations; liaison with schools, courts, and local police; and inter-personal relations training courses for bus drivers designed to reduce their risk of being assaulted.

Equally as important as their differences, there are certain fundamental assumptions held by transit police units to counter criminal activity. Specific police activities such as uniformed patrol, specialized plainclothes units, and decoys are all directed toward controlling crime through the processes of deterrence, prevention and apprehension (see Figure 1). It is also assumed that crime control will lead to several other outcome objectives affecting the well being of the public and urban mass transit system:

- increase ridership perceptions of security;
- increase ridership volume; and
- increase system revenues.

These objectives are interrelated. Changes in crime levels may impact on ridership perceptions of security within the transit system, which, in turn, may lead to changes in ridership volume and transit revenues. Additionally, reductions in certain types of crime (e.g., vandalism, fare evasion, and employee theft) may impact directly on revenues without affecting either public perception or ridership volume.

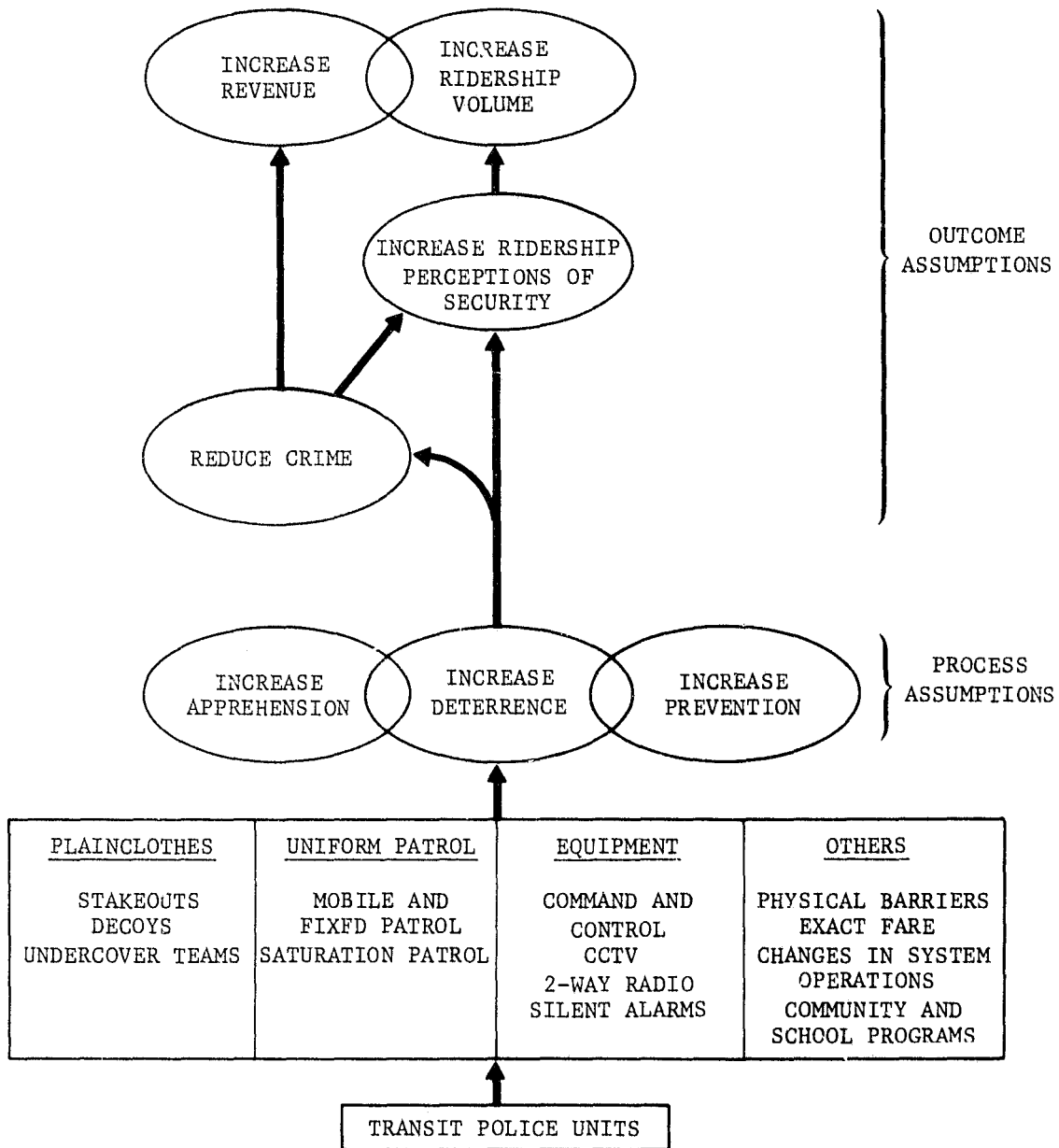


FIGURE 1
TRANSIT POLICE ANTI-CRIME ACTIVITIES AND BASIC UNDERLYING
ASSUMPTIONS AND OUTCOMES

B. Need for Evaluation

An assessment of the state of knowledge concerning policing urban mass transit systems reveals a concentration of research in certain areas and an absence in others.² Several past evaluation studies examine the impact on crime of substantial increases in the number of police patrolling subway systems.³ One major study assesses the effect of exact fare on robberies and assaults of bus drivers.⁴ Additionally, a half-a-dozen or so studies focus on the relationships between policing, crime, and passenger perceptions of security.⁵

² Siegel, L. G., et al., An Assessment of Crime and Policing Responses in Urban Mass Transit Systems.

³ Chaiken, Jan M., Michael W. Lawless, and Keith A. Stevenson, The Impact of Police Activity on Crime: Robberies on the New York City Subway System, The Rand Corporation, R-1424-NYC, January 1974. Also see: Planning Division, Metropolitan Atlanta Rapid Transit Authority (MARTA), Proceedings of the MARTA Security Seminar, October 9-10, 1975. Also see: Porep, Ronald E., "Chicago Police Cut Crime 52% on Public Train Service," Police Times, May 1975. Also see: Reagen, Michael V., et al., Final Report, Public Transit Crime Reduction - Philadelphia Police Department, prepared for Governor's Justice Commission, Evaluation Management Unit, January 1975.

⁴ Stanford Research Institute and the University of California, Reduction of Robberies and Assaults of Bus Drivers - Volume I: Summary and Conclusions, April 1970.

⁵ Broad and Columbia Subway Development Study, Final Report, Broad and Columbia Subway Study Group, Temple University, prepared for U.S. Department of Transportation, Assistant Secretary for Environmental and Urban Systems, August, 1971. Also see: Ferrari, Neal D., and Michael F. Trentacoste, "Personal Security on Public Transit," Transportation Research Forum, 15th Annual Meeting, Vol. XV, No. 1, 1974. Also see: Reagen, Michael V., et al., Final Report, Public Transit Crime Reduction - Philadelphia Police Department. Also see: Shellow, Robert, et al., Improvement of Mass Transit Security in Chicago, Transportation Research Institute and Urban Systems Institute, Carnegie-Mellon University, June 30, 1973. Also see: Shellow, Robert, James P. Romualdi, and Eugene W. Bartel, "Crime in Rapid Transit Systems: An Analysis and Recommended Security and Surveillance System," Crime and Vandalism in Public Transportation,

In general, anti-crime activities employed by transit police have not been formally evaluated in terms of effectiveness in achieving their objectives. Included among these security activities are:

- Plainclothes detail,
 - stakeouts,
 - decoys, and
 - undercover teams;
- Uniform patrol,
 - fixed posts,
 - mobile posts, and
 - canine (K-9) teams;
- Equipment,
 - command and control,
 - closed-circuit television (CCTV),
 - 2-way radio, and
 - silent alarms;
- Other
 - physical barriers,
 - changes in system operations, and
 - community and school programs.

Transportation Research Board, No. 487, 1974. Also see: Thrasher, Edward J. and John B. Schnell, "Studies of Public Attitudes Toward Transit Crime and Vandalism," Crime and Vandalism in Public Transportation, Transportation Research Board, No. 487, 1974. Also see: Transportation Research Board, National Research Council, Newsline, Current Research in Public Transportation Development, Vol. 2, No. 7, August 1976.

Current knowledge concerning the effects of these activities is limited to observations by and beliefs of transit police personnel and to occasional informal assessments conducted by transit police units. There is a need for formally designed evaluations to more precisely determine the effects of various policing activities, so as to provide inputs for administrative decision-making regarding the allocation of resources to maximize transit security.

C. Evaluation: Measures, Data Elements, Designs, and Analyses

The assumption framework, discussed above and depicted diagrammatically in Figure 1, constitutes a structure for assessing the effectiveness of various activities and strategies employed by transit police. The four primary objectives⁶ stated in that framework provide common denominators for assessing the effectiveness of specific security activities and comparing their impact to alternative methods of crime control. The following subsections identify measures needed to assess outcome objectives, delineate data elements required for evaluation, outline several research designs, and discuss various aspects of data analysis.

D. Measures

A number of measures may be used to assess the impact of transit policing activities. Included among these are measures of:

- crime reduction;
- ridership perception;
- ridership volume;
- system revenue; and
- implementation of activities.

⁶ Beside the primary objectives, transit security activities may have a number of secondary objective such as timelier response or increased convictions. While these secondary objectives will not be addressed in this discussion, the above evaluation framework can be easily tailored to incorporate these objectives and associated measures and data elements as part of an assessment of specific security activities.

The first four types of measures correspond to and are derived directly from the primary objectives of transit policing activities. Measures of implementation are needed to link activities to intended outcomes.

1. Reduce Crime

One primary intent of transit police activities--whether they be uniformed patrol, plainclothes units, use of mechanical and electronic equipment, educational presentations for school-age children and so on--is to control and reduce crime in the transit system. Changes in the number and rate of different types of crimes often are employed as measures of crime control activities. Other measures that could be used to gauge the impact of various transit security activities include reduction in the number of crimes occurring at certain locations and/or times, and increases in the number of apprehensions.

2. Increase Ridership Perceptions of Security

Another primary objective of transit policing operations is to bolster ridership perceptions of security in the system. Salient measures in this context concern changes in feelings of security, safety and convenience as well as changes in attitudes and knowledge about security. These measures can be derived from information captured via various survey techniques. Data detailing the demographic and aggregate characteristics of passengers can be used to determine whether specific security activities have differential effects; for example, whether the use of CCTV may bolster captive riders' confidence in the security of the transit system but have negligible impact on non-captive riders' perceptions of security.

3. Increase Ridership Volume

It is assumed that fear of crime is an important factor discouraging the use of mass transit systems. For that reason increases in the number of passengers can be stated as one of the primary objectives of transit police operations. Measures dealing with changes in patterns of usage--routes taken, frequency of use, use of other public or private transportation, etc.--along with measures of passenger perceptions of security would provide some evidence of linkage between changes in ridership volume and policing activities.

4. Increase System Revenue

A fourth outcome objective concerns system revenue. On the one hand, linkage between certain police activities such as random patrol and changes in revenue is somewhat tenuous. On the other

hand, measures dealing with changes in revenue are most appropriate for evaluating the impact of policing activities aimed at curtailing vandalism, reducing fare evasion and decreasing employee theft. Changes in revenue also may be used as one of several measures (along with measures of the other outcomes discussed above) to assess the overall impact of transit policing operations.

5. Implementation Measures

Finally, evaluations should document security activities in order to link policing actions to outcomes. Implementation measures in the context of transit policing may range from the number and content of school education presentations to the form of police patrol (whether in uniform, plainclothes or both) to the movement of officers on an hour-to-hour basis. Changes in implementation activities may significantly affect outcomes; therefore, continuous monitoring employing a host of implementation measures should be included as part of an overall evaluation strategy.

E. Types of Data Elements

The types of data elements needed to compute the outcome and implementation measures pertinent to transit policing activities are presented in Table I. Depending upon the goals of the activities being implemented and assessed, only a subset of these data element types would be relevant to a specific evaluative study.

The data element types shown range from simple counts such as the number of crimes by type or number of passengers by route to attitudes toward security. Data collection methods include analysis of police records, survey questionnaires, and observations of operational activities such as the placement and patterns of police patrols. For evaluative purposes, the raw data elements can be used to calculate rates (i.e., crime rates, victimization rates) and develop and compute indices/scales in measuring, for example, passenger perceptions and police productivity.

Other types of data elements, not directly involved in the computation of outcome measures, often are important in interpreting the effects of transit security activities. Included among these types of data are:

- offender characteristics;
- victim characteristics;
- environmental characteristics;

TABLE I

MEASURES AND CORRESPONDING TYPES OF DATA ELEMENTS

MEASURES	TYPES OF DATA ELEMENTS
CRIME REDUCTION	<ul style="list-style-type: none"> ● NUMBER OF CRIMES BY TYPE, LOCATION AND TIME ● NUMBER OF APPREHENSIONS ● NUMBER OF CRIMES CLEARED BY ARREST
RIDESHIP PERCEPTION	<ul style="list-style-type: none"> ● ATTITUDES CONCERNING FEELINGS OF SECURITY, SAFETY AND CONVENIENCE ● WILLINGNESS TO USE THE SYSTEM BY ROUTES AND TIME OF DAY ● KNOWLEDGE ABOUT SECURITY ACTIVITIES
RIDERSHIP VOLUME	<ul style="list-style-type: none"> ● NUMBER OF PASSENGERS BY LOCATION/ROUTE AND TIME ● FREQUENCY OF USE
SYSTEM REVENUE	<ul style="list-style-type: none"> ● PASSENGER REVENUE ● COST OF CRIMES AGAINST THE SYSTEM (VANDALISM, GRAFFITI, REVENUE THEFT, FARE EVASION) ● COST OF SECURITY ACTIVITIES--MANPOWER, EQUIPMENT, ETC.
IMPLEMENTATION ACTIVITIES	<ul style="list-style-type: none"> ● DEPLOYMENT OF PATROL BY LOCATION AND TIME ● LOCATION AND OPERATION OF SECURITY-RELATED EQUIPMENT ● DETAILS ABOUT OTHER POLICING ACTIVITIES SUCH AS LIAISON WITH SCHOOLS, COMMUNITIES AND COURTS

- demographic characteristics of passengers (e.g., age, sex, race and other socioeconomic variables);
- personal characteristics of passengers (e.g., travel alone or with others, captive or noncaptive rider, and reasons for using system);
- aggregate characteristics of passengers (e.g., ridership density, distribution of riders over time and throughout system); and
- changes in passenger service (e.g., eliminating routes, changing schedules, and raising fares).

These types of data elements are not only useful in providing additional explanatory power but also for identifying and eliminating possible rival hypotheses concerning outcomes (see Subsection II-G.3 below on internal analysis). For example, various security activities may have differential effects on rider perceptions. An increase in police presence may result in captive riders feeling more secure, but have negligible impact on the attitudes of non-captive riders whose perceptions may be influenced more by the media or specific socioeconomic characteristics.

F. Research Designs

There are a number of research designs that may be applied to assess the impact of transit policing activities;⁷ they include: one-group before-after comparison, nonequivalent control group, time series, and multiple time-series. In presenting these designs, each is depicted diagrammatically. An 'A' refers to an activity, the effects of which are to be measured. An 'M' represents a measurement point. Measures taken after implementation are usually concurrent with on-going transit security activities.

1. One-Group Before-After Comparison (one-group pretest-posttest design)

This design compares impact or effects within one group at two different points in time: during the baseline preceding implementation

⁷ Campbell, Donald T. and Julian C. Stanley, Experimental and Quasi-Experimental Designs for Research, Rand McNally and Company, 1963.

of activities and at an appropriate time⁸ after implementation. The design may be diagrammed as follows:

$$M_1 \quad A \quad M_2$$

where $M_2 - M_1$ equals estimated activity effect.

The limits of this design⁹ concern the interpretation of any effects that may be attributed to the activity being examined. Beside the activity in question, effects also may be a function of:

- other specific events taking place either within the transit system or in the surrounding environment between M_1 and M_2 such as an overall change in city-wide crime rates (often referred to as history); and
- extreme high or low levels of crime or police productivity, etc. occurring at the time the activity was initiated (often referred to as statistical regression).

2. Nonequivalent Control Group Design

This design adds a comparison group to the one-group before-after design. In the nonequivalent control group design, the comparison group (e.g., segment of the transit system, time of day, etc.) is not exposed to the activity. The design may be diagrammed as follows:

$$\begin{array}{ccc} M_1 & A & M_2 \\ M_{c1} & & M_{c2} \end{array}$$

where subscript c represents a comparison group and where $(M_2 - M_1) - (M_{c2} - M_{c1})$ equals the estimated activity effect.

⁸The specific time at which M_2 is taken can be very important in assessing effects. Several factors such as estimated time needed to demonstrate possible effects, availability of sufficient data and administrative needs may determine when M_2 is made. This also is relevant to other evaluative designs where one or very few M_2 's are made.

⁹In the context of transit security operations, limitations will refer to threats to internal validity. By internal validity we mean those factors apart from the activity which may influence the results and are not taken into account by the design.

It is important to note that the activity is not randomly assigned. The group receiving the activity is normally selected on the basis of need. For example, a decoy operation may be implemented for parts of the system experiencing high levels or recent increases in robbery and assault.

The nonequivalent control group design has an advantage over the one-group before-after design in that it eliminates the ambiguity of interpretation that may be due to other specific events (history), since both groups are equally exposed to these events.

3. Time Series

This design is quite similar to the before-after comparison except measures are taken at numerous points in time both before and after initiation of the activity. The design may be diagrammed as follows:

$$M_{b1} \quad M_{b2} \dots M_{bn} \quad A \quad M_{a1} \quad M_{a2} \dots M_{an}$$

where subscript 'b' represents measures taken before and subscript 'a' represents measures taken after activity implementation. The measurement of the estimated effects of 'A' is not straightforward. Indications of effects generally will be judged in terms of changes in trends and in the continuity of these changes after the initiation of 'A'.

This design is especially relevant for the measurement of the effects of transit policing activities on crime. Crime appears to have certain time-based statistical and mathematical properties such as seasonality. Therefore, crime should be measured fairly continuously for an appropriate period of time both before and after project implementation. This will allow for better estimates of the effects of the activity by providing a basis for factoring out time-based variations.

The time series design eliminates most threats to internal validity. However, since the design does not include a comparison group, the effects of history still may be confounded with the effects of the activity being evaluated.

4. Multiple-Time Series

This design adds a comparison group to the time series design previously discussed. The multiple-time series design may be diagrammed as follows:

$$\begin{array}{ccccccc} M_{b1} & M_{b2} \dots M_{bn} & A & M_{a1} & M_{a2} \dots M_{an} \\ M_{bc1} & M_{bc2} \dots M_{bcn} & & M_{ac1} & M_{ac2} \dots M_{acn} \end{array}$$

This design has the same advantages as the time-series design. Further, by adding a comparison group, the multiple time series controls for the possible effects of history.

G. Analysis

There are many types of analyses that may be performed on data collected to evaluate transit security activities. These include:

- analysis of main effects;
- analysis of secondary effects;
- internal analysis;
- implementation analysis;
- cost analysis; and
- analysis of external factors.

The types of analyses that may be used are a function of the nature and goals of the activities, the purpose of the evaluation, the research design, and the amount and type of data available.

1. Analysis of Main Effects

The analysis of main effects is directed toward estimating the primary or first order impacts of activities. The main effects are calculated according to the research design selected for the assessment. For example, in a before-after comparison, the difference between M_2 and M_1 represents the main effect. In the case where control groups are employed, the main effect is the difference between the before and after differences for the target and control groups, e.g., $(M_2 - M_1) - (M_{c2} - M_{c1})$. For the time series design, the effects are estimated by measures comparing changes in the trend, slope or periodicity of the time series before and after implementation of activities. The multiple time series adds still another dimension--measuring the differences between the target and comparison groups.

Analysis of main effects deals with direction and magnitude of impact. If appropriate, inferential statistics may be used to

provide estimates of the presence or absence of effects, the generalizability of results, confidence limits, and strength of association between activities and outcomes.

2. Analysis of Secondary Effects

One type of analysis of secondary effects concerns estimating the effects of activities on secondary objectives. For example, saturation patrol may have been initiated to reduce the crime rate, but increased police patrol may also reduce response time. In this example, crime rate represents a main effect and response time a secondary effect. Secondary effects often are included as project objectives and their measurement built into the evaluation process. Additionally, analysis can be performed to determine the relationship between main and secondary effects and estimate the impact of each on the other.

Another class of secondary effects concerns either unexpected outcomes or those overlooked during the structuring of the evaluation design. To illustrate, decoy operations aimed at decreasing robbery in stations A, C, and E may have a spill-over effect, reducing crime in stations B, D, and F that were not targeted by the project. Because they are not included in the evaluation design, unexpected secondary effects often are difficult to measure and usually analyzed ex post facto.

3. Internal Analysis

Internal analysis deals with components or sub-groups of the targeted population or area, focusing on possible interactions. For example, the impact of mobile patrol may be examined for separate segments of the transit system (i.e., routes, stations, etc.) or different time frames (rush hours, late night, and so on). Similarly, a saturation patrol project may be initiated to bolster passenger confidence in security. An analysis of a project may investigate its impact both on the entire sample of passengers and on sample sub-groups delineated along personal and demographic characteristics.

Internal analysis also may reveal project impact in cases where main or secondary effects seemingly are absent. To bolster passenger confidence in security, a transit system may install call-for-aid emergency telephones. A before-after analysis may suggest that the telephones have no overall influence on passenger confidence. However, further analysis of the data may show a statistical association between levels of confidence and type of passenger: captive riders are more confident in the security provided by the transit system, whereas non-captive riders feel less secure. In this general

context, the findings resulting from an internal analysis may be just as meaningful and important to decision-makers as information gained from an examination of main and secondary effects.

4. Implementation Analysis

Implementation analysis is concerned with how the activity is being implemented and performed. The major purposes of this analysis are to monitor the activity to insure it is being carried out as planned and to implement needed modifications. This type of analysis requires measurement over time and provides a basis for determining whether or not the activity conforms with its operational definitions and goals.

The very real possibility that changes in the implementation of activities may significantly affect outcomes underlies the importance of implementation analysis. Moreover, examination of implementation activities may suggest specific lines of data analyses and provide aid in elucidating reasons for particular outcomes.

To illustrate, a new transit police chief decides to implement around-the-clock mobile patrols and evaluate their effectiveness in reducing crime. During the course of data collection, a trained observer determines that the third shift is using fixed post instead of mobile patrol. A before-after analysis of overall crime rates shows no effect. With the knowledge that the patrol pattern was not implemented as planned during the third shift, the evaluator conducts a more detailed examination of the data by time of day (an internal analysis). The analysis reveals that crime rates have dropped for the times covered by the first and second patrols, but increased during the third shift. In this hypothetical example, the evaluator concludes that mobile patrols appear to be effective in terms of reducing transit crime, should be continued for the first and second shifts, and should be operationally implemented during the third patrol.

5. Cost Analysis

Simple analysis of cost is a comparatively straightforward assessment technique. The approach involves comparing the cost (present and future) of the treatment activity with the costs of actions being replaced, modified or supplemented.

A second analytical technique is cost-effectiveness analysis. For this technique, the costs of the target activity are associated with desired outcomes, providing a basis for estimating the cost per unit of effectiveness. By conducting cost-effectiveness analysis for several activities, comparisons may be made between alternative

strategies. Units of effectiveness may present serious conceptual and measurement problems, however, as it may be difficult to translate some outcomes (e.g., increases in passenger perceptions of security, decreases in response time, increases in crimes prevented, and so on) into dollar figures.

6. Analysis of External Factors

Analysis of external factors concerns the assessment of incidents or events that may influence outcomes but are not accounted for by the research design. Two common categories of external factors--"history" and "statistical regression"--have been discussed above. In some instances, the possible influence of external factors (for example, extraordinary coverage by the local press) may be estimated by means of informed opinion. In other cases, the impact of exogeneous events (change in city-wide crime trends, for instance) may be measured and controlled for statistically. Because external events often are posited as plausible alternative explanations for observed outcomes, they should be documented and assessed when possible.

H. A Word of Caution

It should be noted that it frequently is not practical or possible to apply all of the analyses discussed above during the evaluation of specific transit security activities. The types of analyses used will depend on a number of factors such as the complexity of the treatment activity, the availability of data, the amount of uncertainty that can be tolerated and the purposes of the evaluation. In any case, all evaluations should include an analysis of main effects and, at a minimum, an examination of implementation and process activities. The limits of the data and caveats concerning conclusions also should be included in any evaluation report.

SECTION III

CASE STUDY OF THE WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY (WMATA) RAPID RAIL SYSTEM

A. Introduction

An intensive case study of the security operations and crime on the newly operational and expanding Washington Metropolitan Area Transit Authority (WMATA) rapid rail system is recommended as a possible Phase II study under the National Evaluation Program. The newest rapid rail transit system in the country, WMATA was built with considerations for security and safety in all aspects of the system from the design of the stations to the communications equipment in the trains. When the system commenced passenger operations in March 1976, a trained and dedicated transit police force with full police power under experienced management was operational. The size of this force will probably not increase substantially as the system expands in the near future.

The initial phase of passenger operations has been limited to six stations serving a small part of the government, business and shopping areas of the District of Columbia, Monday through Friday. WMATA currently traverses about five route miles, has one parking lot and stops service after 8 PM. The second phase of the system will add 18 more stations, including 12 in the District of Columbia (D.C.) and six in Virginia. There will be about 20 additional route miles extending to the Pentagon and Washington National Airport and into new areas of D.C. Plans for future expansion in the early 1980's include more areas of the District of Columbia; three jurisdictions in Virginia (Arlington County, the City of Alexandria, and Fairfax County); and two jurisdictions in Maryland (Prince Georges and Montgomery Counties). The phased expansion of the system lends itself to a longitudinal case study with important periods of demarcation at times of major expansion. Crime, security operations, and relationships of WMATA with local police agencies can be studied as a function of both time and events viz. increasing numbers of passengers, stations, parking areas, trains and routes, and expansion of operating hours.

The first period of WMATA's passenger operations, from March 1976 to the opening of additional stations and routes in July 1977, can serve, in some respects, as a baseline for crime and security operations data. Given the small number of stations to cover, limited hours of operation, small number of trains and route miles and the relatively large number of police officers, the crime rates during the initial phase of operations may be considered a lower limit of what can be expected under "ideal" conditions. Allocation and deploy-

ment of resources are probably also at an "ideal" level with regard to effectiveness, as there are presently ample resources to maintain a high level of security for the small system. The first 15 months of WMATA's operation may therefore be considered as a baseline from which to assess future crime trends, other security problems and responses to them.

A two year case study, commencing soon after Phase II of WMATA's system becomes operational, is suggested. Data collected should include the first 15 months of WMATA's passenger operations (Phase I) and prior to that, the development of WMATA's Security Department. Several years will most likely be necessary in order to assess the following: development of crime trends and patterns, passenger perceptions and transit utilization; development and changes in police and other security operations; relationships between WMATA and local police agencies; and public and media response to security in the system. The major emphasis of the case study is the examination of changes in crime and responses to crime as the system grows and as new problems and complexities develop.

B. Research Objectives

The case study of the WMATA rapid rail transit system proposes two major objectives. These objectives and their associated research questions are:

Objective One:

- Analyze the emergence of transit-related crime on a new and expanding rapid rail system serving a large metropolitan area to answer the three following research questions:
 - What are the relationships between changes in transit crime and changes in major system parameters such as passenger volume, number of stations, number of patrol officers per station and geographical areas served by the system?
 - What is the association between transit crime and crime in the neighborhoods bordering stations and routes?
 - What is the environmental pattern of transit crime (i.e., is it dispersed throughout the system or primarily confined to a few stations) and how does it affect the allocation of manpower and patrol patterns, passenger perceptions and system usage?

Objective Two:

- Analyze the effectiveness of specific security practices on crime, public and passenger perceptions of crime, and ridership volume to answer the two following research questions:
 - How effective are specific patrol strategies instituted in response to targeted crime problems?
 - To what extent are public perceptions and system usage affected by changes in security operations (which encompass various forms of patrol and use of communications and surveillance equipment)?

Answers to questions subsumed under the first objective will provide valuable information for policing new rapid rail transit systems currently in the planning/building stages. The second objective is oriented toward gaining information to fill major knowledge gaps concerning the impact and effectiveness of various security operations in a rapid rail transit environment.¹⁰ The unique aspects of a new and expanding system, the availability of pertinent data from the onset of transit operations, and the positive research context afforded by a cooperative transit management make WMATA an excellent choice for this endeavor.

C. Data Needs, Sources and Analyses

A new transit system expanding in planned phases, WMATA affords an excellent research context to study the dynamics of crime in a "new" environment, investigate the interactions between crime and policing, and fill many current knowledge gaps. In order to answer the five research questions posited above, specific types of data must be obtained and examined. The following several paragraphs present examples of data as well as sources and methods of collection to be used in the study of crime and policing in the WMATA rapid rail transit system (see Table II for a delineation of the five research questions and corresponding data needs and sources).

As is evident, the research questions are closely linked to one another. Hence, much of the data (e.g., criminal incidents, police deployment patterns and passenger perceptions) have multiple applications and can be used to answer more than one of the questions during the course of the analyses.

¹⁰ Siegel, et. al., An Assessment of Crime and Policing in Urban Mass Transit Systems.

TABLE II
RESEARCH QUESTIONS, KEY DATA NEEDS AND PRIMARY
DATA SOURCES FOR WMATA CASE STUDY

RESEARCH QUESTIONS	KEY DATA NEEDS	PRIMARY DATA SOURCES
RELATIONSHIPS BETWEEN CHANGES IN TRANSIT CRIME AND CHANGES IN SYSTEM PARAMETERS	<ul style="list-style-type: none"> • TRANSIT CRIME BY TYPE, TIME AND LOCATION • TRANSIT CRIME RATES • RIDERSHIP VOLUME OVER TIME • NUMBER OF STATIONS OVER TIME • RATIO OF PATROL OFFICERS TO STATIONS OVER TIME • RATIO OF PATROL OFFICERS TO PASSENGERS OVER TIME 	<ul style="list-style-type: none"> • WMATA POLICE INCIDENT REPORTS • RECORDS FROM AUTOMATIC FARE CARD MACHINES • INTERVIEWS WITH WMATA POLICE
ASSOCIATION BETWEEN TRANSIT CRIME AND NEIGHBORHOOD CRIME	<ul style="list-style-type: none"> • TRANSIT CRIME BY TYPE, TIME AND LOCATION • TRANSIT CRIME RATES • NEIGHBORHOOD CRIME BY TYPE, TIME AND LOCATION • NEIGHBORHOOD CRIME RATES 	<ul style="list-style-type: none"> • WMATA POLICE INCIDENT REPORTS • D.C. AND NORTHERN VIRGINIA POLICE INCIDENT REPORTS
IMPACT OF CRIME DISTRIBUTION ON PATROL PATTERNS, PASSENGER PERCEPTIONS AND SYSTEM USAGE	<ul style="list-style-type: none"> • TRANSIT CRIME BY TYPE, TIME AND LOCATION • TRANSIT CRIME RATES • PATROL PATTERNS AND DEPLOYMENT OF POLICE OFFICERS OVER TIME • PASSENGER PERCEPTIONS CONCERNING FEELINGS OF SECURITY, WILLINGNESS TO USE SYSTEM, ETC. • DEMOGRAPHIC AND AGGREGATE CHARACTERISTICS OF PASSENGERS • RIDERSHIP VOLUME OVER TIME 	<ul style="list-style-type: none"> • WMATA POLICE INCIDENT REPORTS • INTERVIEWS WITH WMATA POLICE • TRAINED OBSERVERS • PASSENGER PERCEPTION SURVEYS • RECORDS FROM AUTOMATIC FARE CARD MACHINES

TABLE II (CONCLUDED)

RESEARCH QUESTIONS, DATA NEEDS AND PRIMARY
DATA SOURCES FOR WMATA CASE STUDY

RESEARCH QUESTIONS	KEY DATA NEEDS	PRIMARY DATA SOURCES
EFFECTIVENESS OF SPECIFIC STRATEGIES ON TRANSIT CRIME	<ul style="list-style-type: none"> • TYPE OF STRATEGY BY LOCATION AND OVER TIME • NUMBER OF POLICE OFFICERS INVOLVED • USE OF COMMUNICATIONS AND SURVEILLANCE EQUIPMENT • TRANSIT CRIME BY TYPE, TIME AND LOCATION • TRANSIT CRIME RATES • NUMBER AND PERCENT OF CRIMES DETECTED BY VARIOUS MEANS • VICTIM CHARACTERISTICS • VICTIMIZATION RATES OVERALL AND BY TIME AND LOCATION • OFFENDER CHARACTERISTICS • APPREHENSION RATES • CLEARANCE RATES 	<ul style="list-style-type: none"> • WMATA POLICE INCIDENT REPORTS • INTERVIEWS WITH WMATA POLICE • TRAINED OBSERVERS
IMPACT OF SECURITY OPERATIONS ON PUBLIC PERCEPTIONS AND SYSTEM USAGE	<ul style="list-style-type: none"> • TYPE OF STRATEGY BY LOCATION AND OVER TIME • NUMBER OF POLICE OFFICERS INVOLVED • USE OF COMMUNICATIONS AND SURVEILLANCE EQUIPMENT • PASSENGER PERCEPTIONS CONCERNING FEELINGS OF SECURITY, WILLINGNESS TO USE THE SYSTEM, ETC. • DEMOGRAPHIC AND AGGREGATE CHARACTERISTICS OF PASSENGERS • RIDERSHIP VOLUME OVER TIME 	<ul style="list-style-type: none"> • INTERVIEWS WITH WMATA POLICE • TRAINED OBSERVERS • PASSENGER PERCEPTION SURVEYS • RECORDS FROM AUTOMATIC FARE CARD MACHINES

Incident reports prepared by WMATA and other local police agencies can provide most of the crime data as well as information on victim, offender and environmental characteristics. These data, in turn, can be employed to calculate crime, victim, apprehension and clearance rates. To assess the impact of crime on policing operations and vice versa, changes in crime levels and rates (overall and for specific segments of the transit system) can be correlated with changes in patrol and deployment patterns. Further, crime levels and rates can be used, along with other indicators, to gauge the effectiveness of overall security activities as well as specific policing strategies.

Counts of the number of riders can be obtained from totals maintained by the fare collection equipment and, along with estimates of the average amount of time a passenger spends in the system, utilized to calculate victimization risk. Computed for different components of the system, types of crimes and specific passenger characteristics, victimization risk can be related to different security activities such as patrol patterns and use of plainclothes officers as well as the development of special projects oriented toward bolstering the security of high risk groups.

Interviews with WMATA police can be used to gather basic information concerning the number of officers, deployment strategies, patrol activities, use of security-related equipment, system parameters and so on. Further, interviews can be designed to explore the impact of changes in crime on patrol patterns and the deployment of officers. Trained observers can provide additional information on police visibility, patrol patterns and other data detailing police actions on a day-to-day basis. Information gathered by observers can be factored into the analyses and greatly aid interpretation of findings.

Passenger confidence in the security of the transit system is an important objective of the WMATA police department. Surveys of transit riders can be used to collect data dealing with passenger perceptions of security, system usage, victimization experiences, demographic and personal characteristics. Moreover, implementation of this type of survey provides an opportunity to develop a handbook for passenger perception measurement (see Section I-F, above). After being field tested and validated during the WMATA case study, the handbook can be disseminated to and used by other transit managers and police department officials as a means for periodically assessing security activities.

Most of the data elements and measures discussed above (e.g., crime, crime rates, passenger perceptions, police strategies) can be analyzed as a function of time and various indices of system expansion (e.g., number of stations, number of passengers, number of

police per station). This approach will necessitate the collection of data at several points in time, at a minimum, before and after expansion occurs. Additionally, activities initiated by WMATA police to deal with specific crime problems may be assessed using one or several of the evaluation designs discussed previously (see Section II-F.).

D. Costs

It is anticipated that the total cost required to complete this 2-year case study effort described above will be approximately \$250,000. This cost estimate includes: (1) technical staff and associate technical staff (research assistant) time; (2) clerical support; (3) expenses for on-site data collection and observation; (4) passenger perception surveys; and (5) computer time.

E. Practical Benefits

The findings from the proposed case study of the WMATA rapid rail system will provide a wealth of information that may be of practical use to several audiences, serving the needs of:

- WMATA police in planning and performing current and future security operations;
- transit managers, planners and police officials mapping out the security of future rapid rail systems or making short- and long-term decisions concerning security operations in presently operating systems;
- government officials charged with allocating scarce resources to transit companies to purchase security-related equipment and subsidize the operating costs of security services; and
- researchers and evaluators developing knowledge and research methods concerning crime, policing and security in urban mass transit systems.

By serving the above groups, the study hopefully will enhance the security of passengers and property. In the long-run, it may contribute to finding ways of promoting greater use of mass transit systems with consequential broader environmental, social, cultural, economic, and personal benefits to the community.

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