PB81-120875

Passenger Value Structure Model
Automated Guideway Transit Technology Program

Dunlap and Associates, Inc.
Darien, CT

Prepared for

Transportation Systems Center
Cambridge, MA

Jul 80

PB81-120875

UMTA-MA-06-0048-79-8

PASSENGER VALUE STRUCTURE MODEL

JULY 1980

AUTOMATED GUIDEWAY TRANSIT TECHNOLOGY PROGRAM

U.S. DEPARTMENT OF TRANSPORTATION
Urban Mass Transportation Administration
Office of Technology Development and Deployment
Washington, DC 20590

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Technical Report Documentation Page

1. Report No.
UMTA-MA-06-0048-79-8

2. Government Accession No.

3. Recipient's Catalog No.
PB81 120875

4. Title and Subtitle
Passenger Value Structure Model. Automated Guideway Transit Technology Program.

5. Report Date
July 1980

6. Performing Organization Code

7. Author(s)
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8. Performing Organization Report No.
DOT-TSC-UMTA-80-23

9. Performing Organization Name and Address
Dunlap and Associates, Inc.*
One Parkland Drive
Darien, Connecticut 06820

10. Work Unit No. (TRAIS)
MA-06-0048

11. Contract or Grant No.
DOT-TSC-1314

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Urban Mass Transportation Administration
400 Seventh Street, S. W.
Washington, D. C. 20590

13. Type of Report and Period Covered
Final Report
Jan. 1977 - Jan. 1980

14. Sponsoring Agency Code
UTD-42

15. Supplementary Notes
* Under contract to U.S. Department of Transportation, Transportation Systems Center, Kendall Square, Cambridge MA 02142. The authors of this report are located at the University of Virginia, Thornton Hall, Charlottesville, Virginia 22901 (a Dunlap subcontractor).

16. Abstract
The objective of this research was to develop a model of the passenger's value structure which would reveal the role and importance of perceived security and other system characteristics on the passenger's evaluation and use of transit systems. The goal is to provide AGT system planners with a tool for predicting the effects of system characteristics or changes in characteristics on the way the user perceives the security of the system.

This report includes: 1) a literature review on perceived security; 2) two models of perceived security; 3) an experimental test (description) of a crime countermeasure and its effect on perceived security; 4) a review of the results of two surveys; 5) refinement of the models based on the results of the experiments; and 6) a discussion highlighting certain findings and suggested future research. In this report, two models of perceived security were developed: one showing the effects of perceived security on transit choice and use; and the other describing the determinants of perceived security. An experiment and two surveys were done 1) to assess the effects on perceived security of a crime countermeasure; and 2) to provide data relevant to the models. Surveys of residents living near two subway terminals were conducted both before and after the experimental installations of a closed circuit TV surveillance system at one of the terminals (Appendix B). The results of this research demonstrate the importance of perceived security to transit users and potential users. This report suggests that transit authorities should consider security as a major component of user acceptance of their system and treat it accordingly.

17. Key Words
AGT Systems, Models/Modeling, Security, Crime, Perceived Security, Planners, Safety, Users, Passenger Value Structure Model

18. Distribution Statement
Report is available to the public through the National Technical Information Service (NTIS), Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified		

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

PREFACE

The U.S. Department of Transportation's Urban Mass Transportation Administration (UMTA), in order to examine specific Automated Guideway Transit (AGT) developments and concepts, has undertaken a new program of studies and technology investigations called the Automated Guideway Transit Technology (AGTT) program.

The objective of one segment of the AGTT program, the Systems Safety and Passenger Security Study (SS&PS), was the development of guidelines for the assurance of actual and perceived passenger safety and security in AGT systems. This work was contracted, through the Transportation Systems Center (TSC), to a team composed of Dunlap and Associates, Inc., the University of Virginia, and the Vought Corporation.

The Systems Safety and Passenger Security (SS&PS) study has involved six related but separate tasks. Three were concerned with the development of guidebooks dealing with: 1) passenger security, 2) evacuation and rescue, and 3) passenger safety and convenience services. A fourth task required the development of a passenger value structure model; a fifth involved research on the retention of seated passengers during emergency stops; and a sixth involved the conduct of a joint Government and industry workshop to review and revise the three guidebooks.

The objective of this task was to develop a model of passengers' value structures that AGT system planners can use to predict the effect of system characteristics or changes in characteristics on the way the public perceives the security of the system. This report includes a review of the relevant literature, the presentation of two models of perceived security, a description of an experimental test of a crime countermeasure and its effects on perceived security, refinements to the models, and a discussion of the findings of this task and their implications for future research.

The authors wish to acknowledge the time and cooperation received from our panelists and the many respondents to our questionnaire. Without the cooperation of transit officials and other experts, completion of this task would have been impossible. The authors also wish to thank the UMTA and TSC technical personnel for their assistance in the performance and documentation of this work, and in particular, Duncan MacKinnon and Robert Hoyler, Program Manager and Monitor, respectively, for UMTA; and Donald Sussman, Project Monitor for TSC, and his professional associate, Janis Stoklosa.

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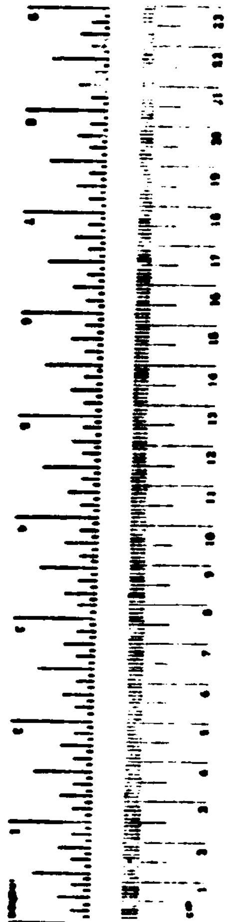
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

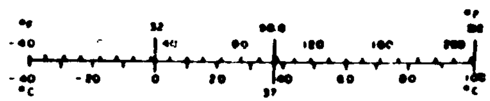


TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

EXECUTIVE SUMMARY

A. INTRODUCTION

The crime problem on public transportation in large urban areas has increased greatly over the last 30 years. In most major cities, peoples' perceptions of safety and security influence their decisions about how to travel within the city. Transit operators need to know how important perceived security is and what influences it. If they understand the basis for the passenger's evaluation of the security of a system, they can develop anti-crime strategies that will enhance perceived security and thereby increase transit system use.

B. PROBLEM STUDIED

The objective of this research was to develop a model of the passenger's value structure which would reveal the role and importance of perceived security and other system characteristics on the passenger's evaluation and use of a transit system. The goal is to provide AGT system planners with a tool for predicting the effects of system characteristics or changes in characteristics on the way the user perceives the security of the system.

These goals were realized through a literature review, theoretical development, and empirical research. A comprehensive review of the literature on perceived security provided the basis for the development of two models.

C. RESULTS ACHIEVED

Two models of perceived security were developed in this report: one showing the effects of perceived security on transit choice and use; the other describing the determinants of perceived security. These models systematically draw together the factors influencing perceived security in transit environments. An experiment and two surveys were done to (1) assess the effects on perceived security of an experimental crime countermeasure (CCTV), and (2) provide data relevant to the models.

Surveys of the residents living near two subway terminals were conducted both before and after the experimental installations of a closed circuit television surveillance system at one of the terminals. A detailed description of the installation is given in Appendix B of this report. The surveys included items on the demographic characteristics of the respondent, the frequency of use of the transit system, the respondents' experiences with crime and vandalism, their perceptions and evaluations of various features of the system, and their feelings of security at various times and places in the system. A copy of the survey is provided in Appendix A.

The data from both surveys provided clear and unequivocal evidence of the role of perceived security in transit choice and use. Except where changes would be expected due to experimental conditions, the results of the second survey replicated those of the first to a remarkable degree. Most respondents in both surveys reported that they did consider security in deciding whether to use the transit system. Security was frequently cited by nonusers as a major factor in their decision not to use the transit system. In a free response item, nonusers were asked to say why they did not use the system: the most frequent reason was that it was unsafe; a substantial number of respondents also complained of sensory aggravation (i.e., noise, dirt, etc.) - a factor related to perceived security.

Almost all respondents said there were times of day during which they were reluctant to use the transit system because of concern for safety and security: these times were most often from 7 p.m. to 6 a.m. During peak traffic periods few people were reluctant to use the system; during off peak periods, many people were reluctant.

A surprising number of respondents reported personal experiences with crime: 11-16% of them had been victims of crime; 26-30% had witnessed crimes. Frequent users were more often victims or witnesses than infrequent users. However, frequent users report better levels of perceived security than infrequent users. Frequent users tend to use the subway system during peak traffic periods and they tend not to use it during off peak hours. These users probably feel that nothing serious will happen to them with so many other people around, but a user during an off-peak period might have greater reason to fear the more serious crimes.

Over three-fourths of the respondents in these surveys feared that they might be the victims of crime while using the subway. Personal security is a very salient concern for patrons of this transit system: it influences who uses the system and constrains the use patterns of passengers.

Perceived security varies with how often the respondent used the transit system and with the sex of the respondent. Frequent users perceived greater security than infrequent users, and nonusers felt the system was extremely insecure. Men in general, found the system more secure than women did. Age of the respondent did not seem to influence perceived security; but other factors related to age may have. Some older respondents reported that ill health and lack of need for transportation prevented them from using the system.

People identify specific times and places in the transit system as safer than others. Night hours are seen as less safe than daytime hours;

the home station is safer than the central business district station; etc. These beliefs appear to be widely shared, and such systematic differences in perceived security should be the basis for allocating police patrols and surveillance equipment.

The survey data were used to check and refine aspects of the two models developed in this project. A discriminant function model was derived to predict frequency of transit use from perceptions of various systems factors: reliability, cost, convenience, comfort, personal security, etc. The values of the weights for each of these factors in the linear combination were computed from the survey data. These weights revealed the importance of perceived security quite clearly; it was the primary variable differentiating frequent users, infrequent users, and nonusers. The discriminant analysis results emphasize the importance of non-economic factors in distinguishing the user groups: those factors that were significant discriminators were: personal security, comfort, and convenience.

The second type of model analyzed the determinants of perceived security, identified factors which should influence it, and proposed equations for determining perceived security given the input factors. Perceived security was analyzed as a function of person variables, station variables, situation variables, system reputation, and security response. The survey data confirmed the importance of sex of the respondents and the person's frequency of system use as determinants of perceived security.

Situation variables which proved important were location (place) in the transit system, time of day, familiarity, and by implication: user density, novelty of use, and concern for security. Station variables were not systematically varied in this research. Only two transit stations in a single system were involved, and only a single countermeasure was investigated. These stations had been selected to be as similar as possible for the experimental test. Thus, this component of the model was not tested in this study. Comments from the respondents emphasized the importance of level of maintenance and degree of sensory aggravation as factors in system evaluation.

Perceived security improved for women in the evening and night hours following the change in security equipment at the experimental station. However, men in general felt less secure after the CCTV was installed. This selective influence of the countermeasure was interpreted as a result of the initial salience of security to the respondents. For men, security was not initially a very salient issue. The security improvements function to increase their awareness of and concern for security. With women, security is already an issue, and the steps taken to improve security selectively improve perceived security for them. This improvement occurs for those times women initially reported feeling insecure.

D. UTILIZATION OF RESULTS

The results of this research demonstrate the importance of perceived security to transit users and potential users. Improved security could increase both the proportion of possible users actually using the system and the frequency of use by current users. Thus, transit authorities should consider security as a major component of user acceptance of their system and treat it accordingly. They should assess whether they have a security problem and allocate their resources (money, manpower, and equipment) to provide adequate levels of security - both actual and perceived.

The models developed here isolate the factors that influence perceived security and thereby help identify features of the transit environment which should concern the transit operator and security force.

E. CONCLUSION

This report includes (1) a review of the literature on perceived security, (2) presentation of two types of models: the role of perceived security in transit use and the determinants of perceived security, (3) the description of an experimental test of a crime countermeasure and the effect on perceived security of the countermeasure, (4) an extensive review of the results of two surveys, (5) refinement of the models based on the results of the experiments, and (6) a discussion highlighting certain findings and suggested future research.

1. INTRODUCTION

How people perceive a transit system determines whether or not they use the system. "We live in a world of perception" (Kinget, 1976), and our perceptions help determine our behavior. With respect to crime, it is perceived crime levels, not actual crime levels, that influence a person's pattern of transit use. We all have fairly definite ideas about crime--its nature and the circumstances under which it occurs. We hesitate to place ourselves in situations we perceive as unsafe. It is perceived safety and security that influence ridership or use of public transportation, not actual safety and security. While actual and perceived crime levels are often related, they are not always so. There are four situations of correspondence between perceived and actual safety and security. A system may be safe and be seen as such, or may be correctly perceived to be unsafe. However, the discrepancies between perception and fact are particularly interesting: the unsafe system that is viewed as safe, and the safe system with a reputation for being unsafe. These cases of misperception may tell us much about what influences users' evaluations of a system. They may help us develop a theory of the role and importance of perceived safety and security in human decisions regarding transportation choice.

These four situations are depicted in Table 1. In each case, the accuracy of the perception is noted and remedial action is suggested where appropriate. In both cases of inaccurate perception, it is necessary to analyze the situation to discover <u>why</u> it is perceived as it is. If the crime rate is actually low, but the situation is perceived as insecure, perhaps the station has conditions or cues that are associated with the

TABLE 1

POSSIBLE CORRESPONDENCE OF ACTUAL AND PERCEIVED SECURITY

		ACTUAL SECURITY	
		High Crime Rate	Low Crime Rate
Perceived Security	Dangerous, Insecure, Unsafe	Accurate Perception - Need to reduce crime level.	Inaccurate Perception - Need to determine bases for perception and change them.
	Safe, Secure	Inaccurate Perception - Need to determine bases for perception. Need to reduce crime level.	Accurate Perception - No corrective action necessary.

occurrence of crime. Alternatively, a rare incident occurring at the station may have occasioned extensive media coverage which exaggerated the crime problem; or perhaps, political and media discussions have led to the general belief that the station has a high crime rate. Finally, the station might be located in a high crime neighborhood and its reputation may be derived from that of the surrounding area.

When a high crime station is perceived as being safe and secure, it is also necessary to ask what conditions or features of the situation lead to the perception. What about the situation reassures passengers?

In any attack on crime in transit systems, there are two problems to be addressed:

(1) to alleviate crime--to cause crime levels to decrease; and

(2) to alleviate the fear of crime--to alter the perception of safety and security; to change the perceived crime level.

Hopefully, if actual crime levels decrease, the fear of crime will also decrease. But it is also desirable to be able to allay fear of crime, especially for a new or innovative system (like an AGT). Such a system should be designed to instill the feeling of security and safety.

The direct literature on passenger perception of crime and security is minimal. The relevant studies are reviewed in the next section of this report. There are more papers concerning the actual effects of crime countermeasures and these are reviewed in detail in the report of Task I of this contract (Jacobson, Richards, Leiner, Hoel, and Braden, 1979). However, most crime countermeasures have never really been empirically evaluated. In the third section of this report, several studies are reviewed which discuss the perceived effectiveness of selected countermeasures. The experiment and surveys discussed in Sections 3 and 4 of this report provide an empirical evaluation of one countermeasure in terms of its effects on perceived security.

1.1 Background Literature on Perceived Security

Various authors have drawn conflicting conclusions about the role of perceived safety in transportation choice. The literature on perceived safety and security is uneven in quality, and several studies have failed to ask the relevant questions. Intuitively, transit users would be expected to prefer the safer of two systems in a modal choice situation. In practice, there are many other relevant factors which may determine the choice, such as availability, convenience, reliability, cost, and frequency of service.

Thrasher and Schnell (1974) have summarized the results of six different studies in five cities, each dealing with the importance of fear of transit crime on modal choice. One of the six studies reviewed by Thrasher and Schnell appears to be the same one reported by Sinha and Roemer (1974). According to Thrasher and Schnell, the Milwaukee study focused on a single bus route (Route 60) which passed through neighborhoods containing a variety of residential, business, and industrial districts. Users covered a wide range of ages, occupations, and racial characteristics. One thousand questionnaires were distributed on the buses during the time frame from 6:34 am to 8:00 pm and 370 of those were returned. Another 1,000 questionnaires were mailed to selected residences along Route 60, and 279 of these were returned. Thus, samples were obtained both on the mode of interest and in the area served by the mode, so that both users and nonusers would be represented in the total sample.

The questions pertaining to crime and vandalism were presented in three different ways. Two of the questions measure the frequency with which safety was singled out from six other factors as an important point about the service. Two questions assessed the respondents' personal experience with crime and vandalism on Route 60. In the third approach, the respondents were asked if there were any times of the day when they would not take the bus because of concern for personal safety.

Responses on the first two questions indicate that personal safety is not a particularly important service factor. Responses on the second two questions suggest that, although personal safety was not the primary concern of passengers, it did play at least some role. It was found that riders were concerned with the "menacing aspects of rowdyism, such as verbal threats and vandalism..." In addition, riders who had personally witnessed serious rowdyism tended to be more concerned with personal safety. Results from the third approach showed a definite trend towards curtailment of use during off-peak hours due to concern for personal safety.

Several aspects of the survey used by Sinha and Roemer should be noticed. When reasons for avoiding use of the Burleigh Street (Route 60) bus were assessed, concern for safety and security is not available as a possible response. A key item is a hypothetical question predicated on the assumption that the person has already decided to take the bus. If he has so decided, then clearly safety must be perceived as adequate. Further, this item asks specifically which service factors would be important, whether or not safety is a service factor is questionable. But the important point is that if a question is phrased so that it assumes that a particular choice has been made, it is not a question about modal choice. Another question asks whether the Burleigh Street bus service is satisfactory or not on several factors: responses to the personal safety subpart of this item are cross tabulated with various demographic characteristics of the respondents. A comparative evaluation of the several factors is not presented, but overall, personal safety appears to be rated satisfactory by most of the respondents. It would be helpful to have a breakdown of responses to all eight factors in this item according to whether the respondents were users or not. The item addresses how satisfactory various service aspects of the bus are, but does not ask whether those factors entered into the decision to use the mode. Other items ask about the respondents' experiences with crime and vandalism, and reports of such experiences were relatively frequent. Respondents were also asked whether there are times during which bus use would be avoided for reasons of security and what those times are. Unfortunately, the relevant analyses of this question are never reported. But the authors do report that people prefer not to use the bus after dark.

Thrasher and Schnell report that a similar study was conducted in Washington, D.C., using essentially the same survey. As in Milwaukee, questionnaires were distributed in the buses along the route (bus route 30) being studied (21 round trips over a single day from 6:30 am to 10:00 pm). In the Washington study questionnaires were not mailed out; rather they were distributed at six shopping centers throughout the Washington area. Of the 4,037 questionnaires distributed, 2,054 (50.88%) returns were usable. The results were similar to those for Milwaukee: the first two questions suggest a much weaker concern for safety than the results from the other two approaches. As in the Milwaukee study, a much greater concern for crime was found among persons who had witnessed or experienced crime, and 30% of the respondents felt that there were times they would not ride because of concern for personal safety. Twenty percent of the Washington respondents felt that the safety of the route sampled was poor.

Two other studies, one in Baltimore and one in Cleveland, looked at the effect of a particular violent crime along a transit route on the ridership of that route. The Baltimore incident occurred on August 2, 1972, when four young men, all under 20, boarded the MTA westbound route 5, threatened the driver and passengers with a revolver and shotgun, and took $160 in cash and $161 in checks. No one was injured and four suspects were apprehended within 30 minutes. MTA had conducted a traffic check three weeks prior to the incident and a new traffic check was done seven days (8/9/72) after the incident. Although there was a slight decline in ridership after the incident, the difference was not significant. There are several features of this incident that should be noted. First, Thrasher and Schnell give no indication that this incident was typical or frequent. If it was an isolated incident in an otherwise safe system, it would not be expected to have effects on ridership. Second, given the swift apprehension of the criminals, any media coverage of the event would report the capture along with the robbery, and thus give an impression of an alert and competent police force. Third, the traffic count is probably not a very sensitive measure and thus the study could not show any effects of perceived security on ridership. Only a passenger survey could have done that. Fourth, there was no attempt to relate this data to that for a control route or to a stable statistical baseline.

The Cleveland incident consisted of a homicide on January 18, 1970, at the Superior Rapid Transit Station. Ridership was tabulated weekly for the two weeks before and the three weeks after the incident for the Superior Station and for several other east-side stations. Ridership at all east-side stations was 4.0% less the first week after the incident and 1.1% and 1.5% less for the second and third week, respectively. Ridership at the Superior Station was less than the other stations over all three intervals after the incident (with the exception of one station which showed a slightly greater decline over the first week). This would suggest that the homicide had at least some effect on ridership at the Superior Station. However, when the first five months of 1970 are considered, the Superior Station showed a slightly smaller rate of decline than the other east-side stations considered together, suggesting that any effects of the incident were limited to the period immediately after the incident. Thrasher and Schnell assume that the Cleveland Transit System considered and discounted all other possible factors which might have caused the ridership decline, but note that the CTS report they were quoting did not explicitly say so.

Thus, in both of these studies, little was done to control for the possible effects of other factors. The Baltimore study results are ambiguous as no between station comparisons were made. The Cleveland study does make such comparisons and controls for factors common to all east-side stations, but there may be factors unique to the Superior Stations which were not controlled. This sort of difficulty is inherent in any study of this type. Only replication with similar results over several such incidents would alleviate the problem, and allow one to reach a conclusion about the influence of a crime on ridership.

Attitude studies done in Chicago used two approaches to the role of perceived security. In the first, respondents were asked if they agreed or disagreed with each of six statements. Personal interviews were obtained from each of 200 households. The respondents were asked if "there is no reason to be concerned about riding CTA during the day," where disagreement was taken to indicate concern for security. Based on percentage of disagreement, this statement ranked fourth in importance among the other five factors. This result was taken to indicate that security was not a major concern.

This method is unsatisfactory for measuring perceived security. First, it does not separate the effects of other service factors that may also affect the use during the day. Second, it does not measure concern for security during the night. The Milwaukee and Washington studies found concern for security to be greatest during off-peak hours.

In the other Chicago study (Thrasher and Schnell, 1974), panels of 8 to 10 non-Black residents were asked to describe situations in which they decided whether or not to use the CTA. There were four groups and members' age ranged from 20 to 60 years old. The authors note that the results were not tabulated. But, they say, the respondents did give some idea of the sort of situations they found anxiety provoking. Generally the el/subway created the greatest anxiety because it was felt that help would not be available if needed. Anxiety was less during peak periods and there was some indication that some passengers timed their trips to coincide with peak periods. The panel data showed a high concern for personal safety, but the small sample size and the nonrepresentative composition of the panels do not permit generalization to the transit population in general. Other studies have shown that the White population is more concerned about crime, hence the results may give inflated estimates of concern for crime (Siegel, et al., 1977).

However, the greatest cause for concern in this Chicago study comes from the authors' observation that the findings were not tabulated. The conclusions must have been impressionistic. The problem with impressionistic results is that the investigator may notice what he is looking for and not notice, or not attend to, the contrary evidence that is present in the discussions of the panel. The conclusions reached may well be true, but this evidence does not establish them. However, they do provide some interesting hypotheses for further study.

Another Chicago study examined the conditions under which CTA passengers reported feeling secure. Telephone interviews were conducted with 1586 persons sampled at random from all Chicago households. Respondents were asked 45 questions, two of which dealt with safety: (1) "While using the CTA, under which conditions do you feel most secure and under which do you feel least secure?"; and (2) "Which of the following conditions makes you feel most secure?" After each question, respondents were given a list of conditions from which to select their response. In general, people felt most secure if they knew there was a high probability of obtaining help when it was needed. Concern for safety was least when actually riding the bus or el and when returning home from the ride on the bus or el. Zones of perceived safety within the transit system were established: people felt least safe on the stairs, ramps, and platforms of a station.

They felt more secure riding in the train than waiting in the station. Thus, this study suggests what situations from among those presented worry or reassure the transit user. It does not establish whether concern for safety actually influences system use.

The six studies reviewed by Thrasher and Schnell seem to give inconsistent results, but whenever respondents were directly asked about safety, it seemed to be a factor in modal choice and in the frequency and pattern of system use.

Ferrari and Trentacoste (1974) surveyed Chicago residents along a bus route which was selected because of its proximity to an el (elevated train) route serving the same areas. Thus, a situation was found in which mode choice was possible and for which convenience, cost, travel time, and comfort were about equal on the two modes. Surveys were distributed both through personal contact and by mail. Bus users were approached with the questionnaire at selected sites. A total return rate of 18.5% was achieved (371 questionnaires completed), but this represented a 12% return rate for the mail surveys and a 33% return rate for the personally distributed ones. Despite the small overall return rate, this study has several good design features and, therefore, its conclusions will be reviewed in detail and compared to those of other workers. In comparing bus versus el use, safety was one of the most important reasons patrons gave for choosing the bus over the el when other service factors were held constant. The el/subway system in Chicago was rated much less safe than the bus system. This difference was greatest among el nonusers.

Nonusers have in general been found to place a much greater emphasis on security and to perceive much lower levels of security than users of the system. In a Washington Study of transit bus security (Thrasher and Schnell, 1974), 40% of the people who did not take the bus thought that the security on the route used in the study was poor as opposed to only 13% of the bus users. However, it should not be concluded that concern for security was the principal reason for nonuse.

Among demographic variables, sex, age, and frequency of use tend to be the most important in relation to perceived security. Ferrari and Trentacoste (1974) found that females are more concerned about safety than males. A study by Olsen, et al. (1973) of a demonstration bus system in Clearwater, Florida, also found a significantly greater concern for safety among females. In both studies older passengers were much more concerned about safety. Olsen, et al. also found a much greater concern for safety among people with health problems.

Several environmental factors have also been found to influence perceived risk. In the Milwaukee study (Sinha and Roemer, 1974), concern for safety increased as distance from the inner city decreased. Ferrari and Trentacoste (1974) found a seasonal variation in the level of perceived safety. Winter was perceived as being significantly more dangerous than the warmer times of year. Ferrari and Trentacoste attributed this to the earlier occurrence of darkness in the winter months and to the use of the transit system by tramps, drunks, and other bothersome persons as shelter from the weather.

Siegel, et al. (1977) have summarized and evaluated the results from several studies of perceived safety and security. They have offered several general conclusions: (1) transit crime seems to have at least some role in determining passenger perception and ridership; and (2) the importance of perceived safety varies with the volume of crime in an area, the availability of alternate modes of transportation, and time of day; (3) within modes, differences can be found in the perceived safety of different parts of the system, and (4) perceived safety does not always mirror the true safety performance of a transit system. According to Siegel, et al. (1977), people are generally correct in their attribution of risks to different types of systems, different times of day, and different aspects of the same system.

A panel study of perceived security was conducted by Feldman and Vellenga (1977). They used the Focus Group Interview technique to collect attitudes toward public transit in the city of Chicago. Homogeneous groups of nine respondents each were formed. All members of each group were of the same race (Black or White), sex and residential designation (city or suburban dweller). Thus, one group consisted of nine Chicago White males, another of nine Chicago Black females, etc. There were eight such groups in all, and both users and nonusers were present in each group.

The results are presented by the authors as a series of general conclusions followed by specific comments to illustrate the "conclusion." These "results" should be taken as hypotheses to be verified by other data or to be used in the design of future studies. They cannot be taken as proved or supported by this type of study. In general, security or personal safety does concern the members of these groups, although there appeared to be differences between groups in its salience. Group members expressed both generalized fear (of the transit system as whole) and location specific fears (downtown). Respondents indicated that they were unlikely to use the el during off-peak hours for fear of crime, and they were most fearful of night use. Concern was expressed for family security; many respondents didn't want their family members using the el. Men appeared to be more concerned about family security than women.

Group members felt that if they were threatened while using the transit system, neither transit employees nor other passengers could be expected to help them. These groups did indicate that various security measures (alarm and communications systems, more police patrols) would make them feel more secure, but many members were unaware of security equipment and procedures already in use. Finally, various defensive behavior was described. People try to protect themselves and their property by sitting in certain locations and avoiding specific people and situations. This article is an especially rich source of hypotheses to be studied in detail in future work. It is highly suggestive regarding a theory of perceived safety and indicates the need for extended follow up surveys.

1.2 General Studies of System Characteristics and User Reactions

To understand user attitudes toward transportation systems, we need to determine: (1) what are the perceived attributes of each system--what do people believe about each; (2) what is the evaluation of the system; (3) which attributes, or beliefs, are relevant to that evaluation; and (4) how does the affect associated with the various beliefs combine to yield the global attitude?

Factors which should relate to how people evaluate transportation systems include cost, convenience, comfort, scheduling, safety, and security. These factors all involve system characteristics and are under partial control of transportation planners and policy makers. In each case we can distinguish between a set of physical measures of system characteristics and the passenger's perception of those characteristics. The problem for a transportation planner is to obtain quantitative indices of system variables which predict people's reactions to the system and influence modal choice and vehicle use.

Most prior surveys have ignored both accident safety and personal security as factors in modal choice, either because they were assumed not to be problems or because it was assumed that all modes were about equally safe and secure (or equally dangerous). The several studies reviewed below suggest an important role for safety and perceived security when it is asked about.

Zakaria (1975) conducted a series of surveys concerned with criteria for urban transportation systems. He surveyed both transportation experts and the general public in the Delaware Valley Region. All subgroups in his study rated safety as the primary attribute any system must have. His general conclusion is that "people want safe and reliable transportation without disruption of their communities or neighborhoods" (p. 535).

Safety also appears as an important factor in studies of airline passenger preferences. Using factor analysis and multidimensional scaling, Jacobson and Martinez (1974) analyzed the components of comfort and satisfaction for air travelers. Comfort was determined by three environmental factors which they interpreted as ride steadiness (motion), sensory aggravation (noise, smoke), and work or activity facilitation (lighting, work space). Satisfaction was found to be a composite of safety, convenience, luxury, and in-flight activity dimensions.

Richards and Jacobson (1975) had airline passengers rate the importance of various factors as determinants of satisfaction with air travel. Safety and reliability were extremely important; followed, in order, by time savings, convenience, comfort, cost, on-board service, surroundings, and ability to work. The environmental variables perceived as most important to overall comfort were seat comfort, noise, temperature, and motion characteristics. Sex differences were apparent: women rated motion characteristics as more important and seat comfort as less important than men did. Jacobson and Richards (1976) related rated comfort to measured characteristics of the physical environment; vertical and transverse accelerations were found to dominate the comfort rèsponses. Comfort was shown to determine willingness to fly again, and thus satisfaction with the travel mode.

Richards, Jacobson, and Ransone (1978) studied modal use and choice criteria for short out-of-town trips in two Virginia cities. Their sample was not associated with any particular mode of transportation by virtue of the sampling procedure. However, most respondents make most of their trips by car. Respondents from both cities rate safety as a very important factor in their decision to use a particular type of transportation. Paradoxically, the most used form of transportation, the private automobile, is considered unsatisfactory in terms of safety by one-quarter of the survey respondents. The least used forms of transportation (train and intercity bus), however, were considered unsatisfactory in terms of dependability, convenience, travel time, schedules, and cleanliness. There is a consistency here: both convenience and dependability were rated more important than safety as factors in choice of how to travel.

It is important to note that people's concept of safety may be different for public transportation versus private vehicles. Safety for cars may mean simply freedom from accidents, while safety for public transit also includes security from crime. Thus a general rating of safety may not be comparable across the two vehicle types.

Dobson, Golob, and Gustafson (1974) asked respondents to rate their preferences (in a paired comparison task) for a set of 32 transit attributes. They then used two preference models, the unfolding model (Coombs, 1964) and the vector model (Tucker, 1960; Carroll, 1972), to abstract structural representations of the variation in preference judgments. The six dimensions isolated by the vector model appear to be (1) level of service, (2) convenience, (3) cost, (4) avoidance of annoying people, (5) personal space, and (6) comfort, or control. The vector model results did relate to socioeconomic and demographic variables, but the unfolding model results did not.

Dobson and Kehoe (1974) used a variation of the Tucker-Messick scaling procedure (Cliff, 1968) to analyze similarity ratings for a set of twelve attributes of transportation systems. The attributes were all appropriate to an automated urban transportation system. The first phase of the analysis isolated seven distinct groups of respondents, each representing a different point of view about the attribute space. Three recurrent dimensions of attribute variation were identified: basic transport service, personal luxury service, and general amenities.

Costantino, Golob, and Stopher (1974) explored consumer preferences for the same twelve system attributes and three vehicle types as had Dobson and Kehoe. They obtained satisfaction ratings for each vehicle on the twelve attributes and an overall satisfaction rating for the vehicle. A factor analysis performed on the attribute satisfaction ratings yielded five dimensions which were interpreted as level of service, comfort and privacy, degree of automatic control, cost, and amenities. The same factors emerged, regardless of trip purpose (work or shopping). Regression analyses were performed relating the factor scores to overall satisfaction: for work trips, level of service (and time) predicted overall satisfaction, while for shopping trips, comfort and amenities were most important.

Foerster, Young, and Gilbert (1975) studied the changes over time in user and nonuser perceptions of a new transit system in Chapel Hill, North Carolina. The transit (bus) system was totally new to the town. Two mail surveys were conducted: the first just before the bus system started operating; the second after it had been operating for eight months. There was considerable overlap in the two samples. Both surveys asked about mode choice, level of information (familiarity) with the bus system, and demographic information. The first survey asked about the features desired in an ideal transit system (level of service, cost, timing, scheduling, etc.). The second survey included attitudinal items about auto and bus travel and perceptual items about cost, convenience, safety, etc., of the two types of vehicle. Both surveys asked for ratings of the importance of 19 attributes of transportation systems. Respondents were divided into bus users and auto users. Differences in importance ratings were apparent for respondents in these two groups. Both groups showed changes in preferences over the eight months of bus service. Further, individual differences were apparent within the set of users of each mode.

Perhaps the most important finding in this study is that the attribute preferences expressed by bus users changed with experience in the system. User expectations were more realistic in the "after" survey. This finding should make us cautious about accepting data based solely on what a potential user thinks he might do or feel when faced with a new transportation system. We need to understand how users evaluate attributes with which they have some experience in order to confidently predict how they will react to innovation. Foerster, et al.'s study provides another example of Zajonc's assertion that "familiarity breeds comfort."

The crime problem on public transportation in large cities has increased greatly over the last twenty years. Surely in most major cities, perceived safety and security influence peoples' decisions on how to travel within the city. The studies cited in Section 1.1 show some effects of perceived security, while those in Section 1.2 attempt to relate security to other factors. Unfortunately, few of these latter studies separated the effects of accident safety and perceived security. In the next section, these literatures will be used to provide hypotheses for the development of a theory of perceived security and models of the determinants and importance of perceived security.

2. PASSENGER VALUE STRUCTURE MODELS

There are two kinds of models needed to understand perceived security: (1) a model to describe the role of perceived security in mode choice and use - does perceived security determine whether people use a transit system or not? Does it influence when and how they use the system? How is perceived security related to other determinants of mode choice--such as comfort, convenience, scheduling, etc?, (2) a model to describe the determinants of perceived security--what factors influence when a person feels secure or insecure? What aspects of the transit environment reassure people and which ones make them feel fear or discomfort?

In both cases, various hypotheses can be formulated from previous research, from interviews with security personnel, transit users. and transportation researchers, and from the experience of the authors, as both users of urban transportation systems and researchers.

The components of a theory of passenger evaluation of safety and security are shown in Figure 1. Input to the individual may be direct, indirect or both. One may obtain information about transportation systems through experience with the system or indirectly, from the media, advertising, or contacts with other people. The theory traces the processing of this information through the stages from perception to ultimate intention to use or not to use the system. Components will include models of perceptions, beliefs, evaluations, attitudes, values, decisions and intentions. The content of these constructs are statements about transportation systems and their attributes.

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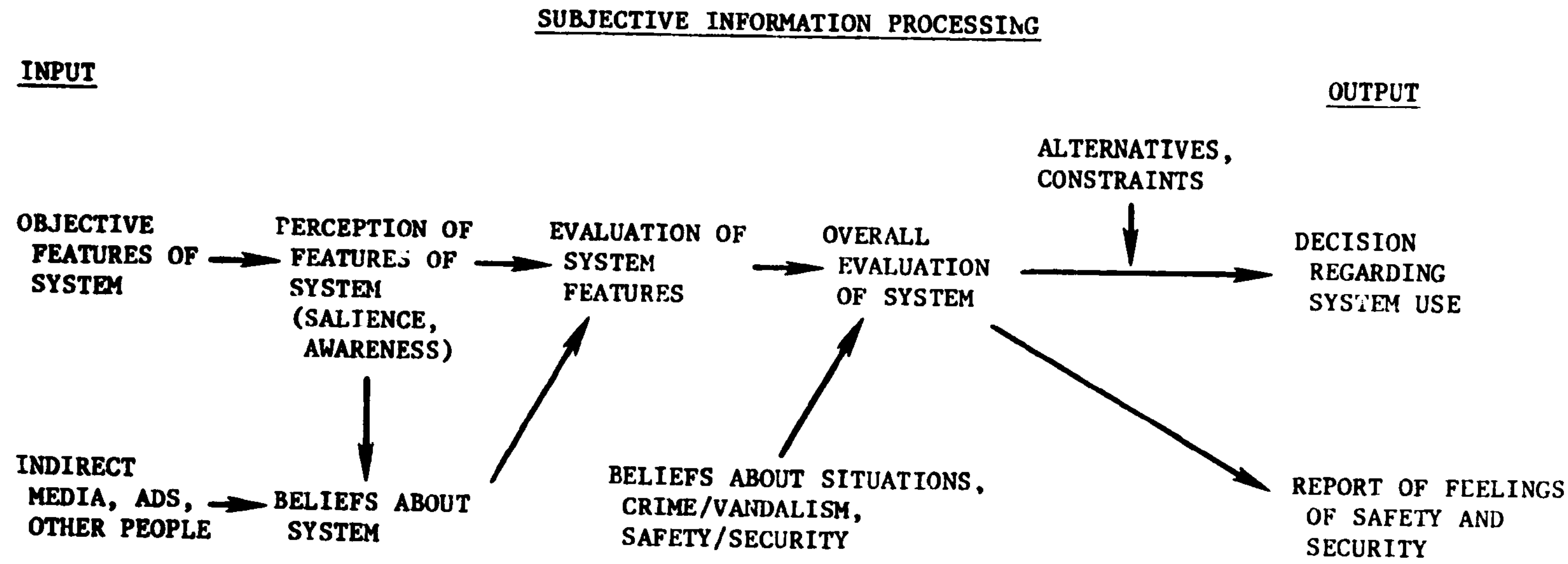


Figure 1. Information Processing Model

Figure 2 shows a specific environmental feature whose effects are traced through the model. Level of employee presence may be directly perceived, or may be known indirectly because of advertising, instruction or media coverage. Thus, a person may know that a police officer comes through the station every twenty minutes even though he has never seen one in the station. This knowledge will influence his level of felt security which influences his intention to use the system. A particular representation of this variable will be proposed in Section 2.2.

Perceived security is an intermediate impression (or construct). It is derived from, influenced by and dependent upon a variety of factors. It is also one of several determinants of a user's overall impression of the transit system and his or her eventual use and pattern of use of the system. Thus, two models will be described in the next two sections: a model of the role of perceived security in modal choice (Section 2.1) and a model of the determinants of perceived security (Section 2.2).

2.1 The Role of Perceived Security in Transit Choice and Use

Perceived safety and security is one of several factors influencing transportation choice. Others are comfort, convenience, cost, dependability, scheduling, system image, time saving, stress of using system, and others. Each of these constructs or factors represents an impression about a transportation mode. Such impressions are global--not particular statements about features of the modes. Thus, the person believes and states "buses are inconvenient," "trains are uncomfortable," and "cars are dependable." If you ask a person "why?" or "what do you mean by that?" he can, of course, generate particulars (concrete examples supporting the construct or impression), but the impression is probably the key variable in modal evaluation and choice, not the particulars.

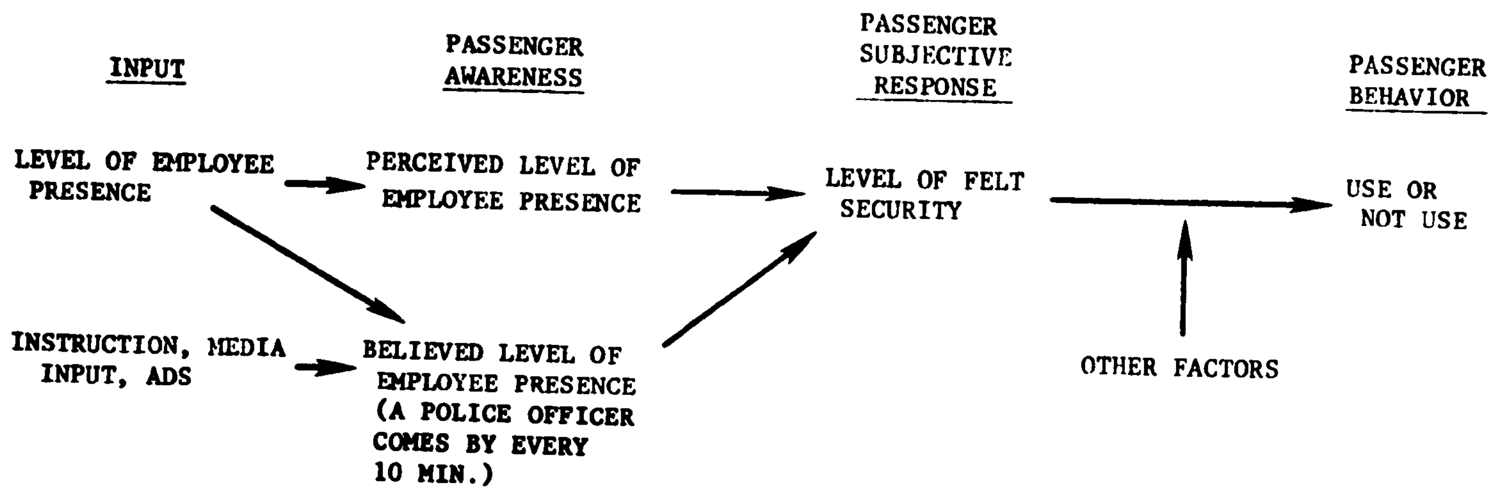


Figure 2. Example of the Effects in the Model of a Specific Environmental Feature

People evaluate each vehicle or transit mode in terms of their impressions of its safety, convenience, comfort, etc. The quantification of each of these constructs (variables in our model) simply requires judgments from people. If we ask people to do it, they can give us ratings or rankings of various transportation systems on these constructs. Further, each construct or impression is the result of various situations or conditions, and, if asked, people could tell us why they evaluate the feature in that way. The basis for an impression may differ for different people. Thus, the bus may be rated highly inconvenient by one person because the nearest stop is 10 blocks from his home and by another person because it doesn't run often enough.

The user impression of greatest concern in the present report is perceived safety and security, but in order to understand its role in modal choice it is necessary to study it in the presence of other impressions or constructs which also influence whether people use a particular mode. A variety of possible determinants of modal choice must be examined to see which ones are relevant, and critical. An initial test of the relevance of an impression is whether users and nonusers differ on it: if users and nonusers do not differ in how they rate the safety of a system, then perceived safety is probably not a critical feature in modal choice. The simplest evaluation model is a linear combination of the attribute variables. Thus standard linear regression techniques can be employed to arrive at an expression:

$$E_{Transit} = f\ (\text{comfort, safety, cost, etc.})$$

where the function is a simple linear combination:

$$F_{Transit} = a + bX_{comfort} + cX_{safety} + \cdots$$

In this framework the influence of perceived safety and security would be apparent from the regression weights associated with it in the usual regression model. Thus, one's evaluation of a mode of transportation is a function of several variables. Each mode is assumed to have a value on each variable and each variable is weighted by a coefficient indicating its importance or salience. Choice is determined by the relative values of the modes on the evaluative dimension.

Our model of the role of perceived security in modal choice will be such a linear function. It will involve a set of ten variables assumed to influence mode choice. These are reliability, convenience, cost, frequency of service, comfort, accident safety, condition of vehicle, condition of stations, frequency of police patrol, and personal security. The first five variables represent the usual system factors appearing in past models of transportation choice. Of the last five, accident safety is included to be able to differentiate its effects from those of perceived security. The other three variables are included as possible correlates of perceived security.

The appropriate model will be determined by a discriminant analysis using these ten variables to differentiate three user groups: frequent users, infrequent users, and nonusers. Prior to data collection, it is possible to specify the probable form of the model (a linear combination of variables) and the variables which are candidates for inclusion in the model. Data must be collected to determine which of these variables (if any) are important and what their relative influence is on transit use. A picture of this first type of model is shown in Figure 3.

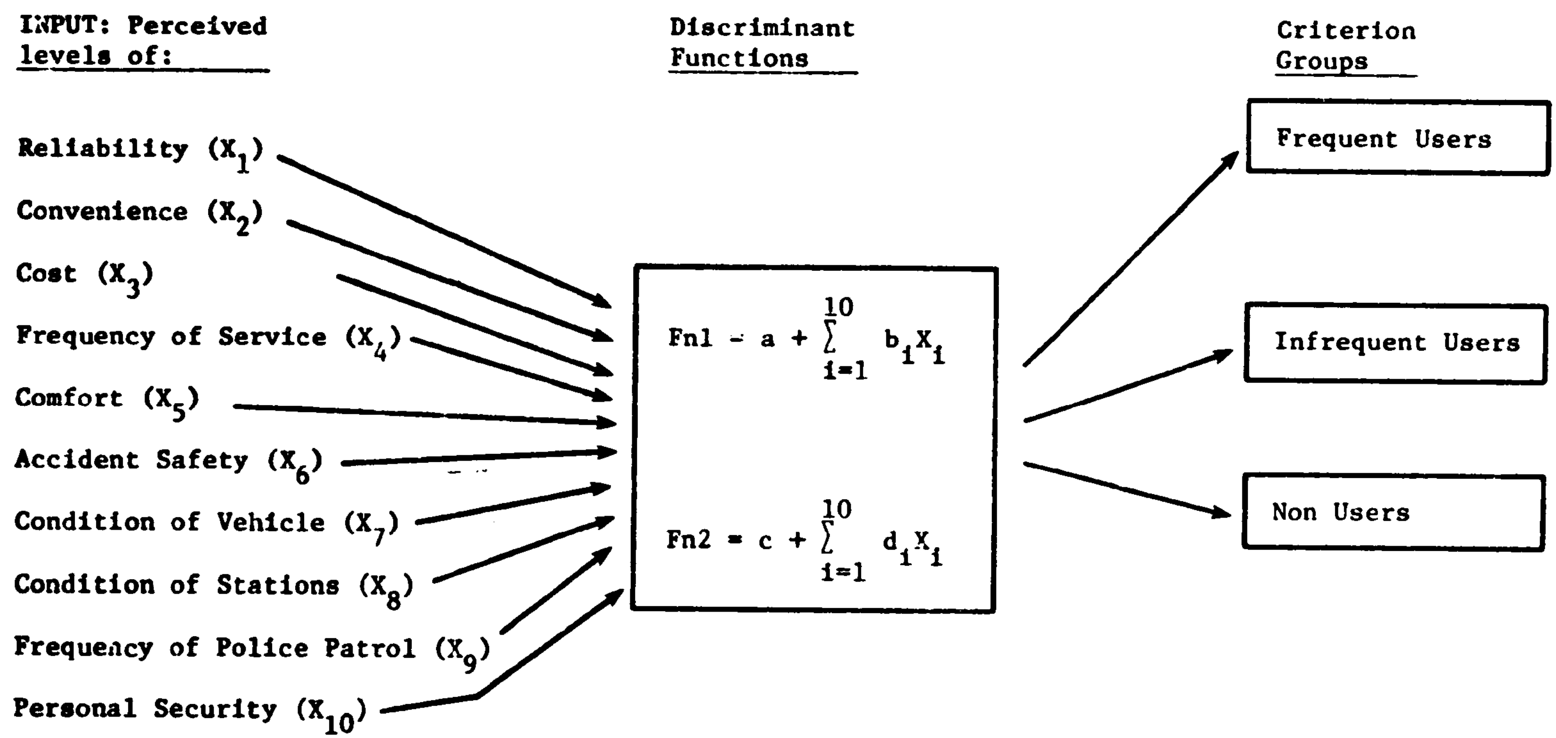


Figure 3. Model of the Role of Perceived Security in Transit Evaluation and Use

2.2 Determinants of Perceived Security

Successfully modeling the role of perceived safety and security in modal evaluation is only part of our problem. The other major part concerns how a person obtains or develops his feeling of safety and security and what factors influence it. What determines how safe an individual will feel in a particular situation? We shall distinguish three types of variables in this model: (1) user variables, (2) station variables, and (3) situational variables. The first two represent relatively permanent (or slowly changing) features of the user or station. The last represent temporary features - and are a function of the interaction of the user and the environment of the station. Perceived security (PS) is a function of all three types of variables; thus,

PS = f (user variables, expectations, station variables, and situational variables).

Each of these categories of variable will receive a composite score in the model, but the variables themselves represent the important determinants of perceived security.

2.2.1 User Variables

Various characteristics of the person using the transit system may influence perceived security. Clearly, security will be an issue, and lower levels of security will be attributed to the system, if one is vulnerable (elderly or in poor health). Evidence also suggests that females perceive lower levels of security for the same system than men do.

Relevant passenger variables and their respective values and scores are listed below (higher scores will be associated with greater perceived danger; i.e., lower perceived security):

Variable	Values	Scores
Sex:	Male	1
	Female	3
Age:	Young (<35)	1
	Middle (35-65)	3
	Old (>65)	5
Physical condition: (health)	Good	1
	Poor	5
Experience with transit system:	Frequent user	1
	Infrequent user	3
	Nonuser	5

There are, of course, many other potential ways to characterize the persons who use transit systems, and some of these other variables may influence perceived security. The above list represents those variables for which there is prior evidence of their effects on perceived security (see Section 1.1). A composite variable representing the sum of the person characteristics has a range of values from 4 to 18, and thus average values ranging from 1 to 4.5.

2.2.2 Station Variables

Physical aspects of transit stations may influence how secure a person perceives himself to be in the station. Well lit stations are assumed to be more secure than poorly lit ones; dirty stations are seen as less safe than clean ones. Station variables also include characteristics of the area and neighborhood surrounding the transit station. Several ways of assessing station security have been proposed.

One procedure was developed by the Institute of Urban and Regional Development of the University of California at Berkeley for assessing security levels for stations in the BART system. This instrument and its use is described in Demetsky, Hoel, and Virkler (1976). The scoring procedure is based on summing the values for each of several indicators of station security. Those values depend on explicit assumptions about the design features that improve or diminish security. Some of those assumptions are: (1) the presence of an area limited to paid users improves security, (2) the fewer exits there are from the paid area, the better the security, (3) proximity (closeness) to a station agents' booth, a courtesy phone, or a major user path enhances security, (4) if an area is visible from a station agents' booth or under CCTV surveillance, security is improved, (5) obviously poor lighting and areas which could be used for hiding both severely diminish the security of the station, (6) higher passenger volume is associated with greater security, (7) fewer station levels provide better security, (8) surface and aerial stations are more secure than subways, (9) suburban stations are more secure than urban stations, (10) residential area stations are more secure than those in commercial areas, (11) the lower the land use density surrounding the station, the better station security will be, and (12) the absence of parking facilities improves security.

Harris (1971) proposed a set of three surveys as part of "A Methodology for Developing Security Design Criteria for Subways." His survey II deals with station design; it assesses in detail the physical environment provided by the station, as well as features of the area surrounding the transit station.

For the present model, aspects of the physical environment which appear to be related to perceived security were included. Many of these variables appear in the Harris and Bart surveys. The variables, their levels, and scores for each level are shown below (as before, higher numbers reflect poorer security):

Variable	Values	Scores
Internal Lighting	Bright	1
	Adequate	3
	Dim	5
	Very poor	7
Age of Station	New	1
	Old	5
Cleanliness	Clean	1
	Dirty	7
Level of Maintenance	Good (well maintained)	1
	Bad (poorly maintained)	7
Degree of Sensory Aggravation	Non intrusive	1
	Noticeable	3
	Annoying	7
Visibility Throughout Station Interior	Good	1
	Some obstructions	3
	Limited	5
Neighborhood Surrounding Station	Low crime area	1
	High crime area	5

Most of the above variables are obviously related to perceived security. People will feel less safe in stations that are old, dirty, poorly maintained, and poorly lit than in modern, clean, well maintained and well lit ones. The negative features represent cues that are associated with crime occurrence and with lack of care and attention by the transit authority. The positive features are associated with safety and security and with transit system commitment to the facilities and therefore the users.

The degree of sensory aggravation is related to some of the other variables. If the station is dirty, smelly, noisy, filled with grafitti and so forth, then users will view it as less secure because these cues are associated with unsafe environments. Further, sensory aggravation itself leads to discomfort and annoyance - which may lead to incidents.

The area surrounding a transit station will influence how the station itself is perceived. A station in an unsafe neighborhood will be assumed to be unsafe.

A composite variable representing the station security has a range of values from 7 to 43 and average values ranging from 1 to 6.14.

2.2.3 Situational Variables

The characteristics discussed above were relatively permanent features of the person or the transit station. Situational variables are characteristics of the particular interaction between the person and a transit environment. They characterize aspects of an interaction which is temporary, or limited in time. Situational variables may be classified as personal, social, and physical.

Personal variables are those that refer to the person in the situation. The key variable here is familiarity with the transit station. A person will feel more secure in a familiar environment than in an unfamiliar one. Familiarity with the system or the part of it being used enhances perceived security. A related psychological variable is the novelty of the trip being made: is this a usual, regular, habitual use of the transit system or is the person making a unique or novel use of the system? Habitual uses will be associated with greater perceived security.

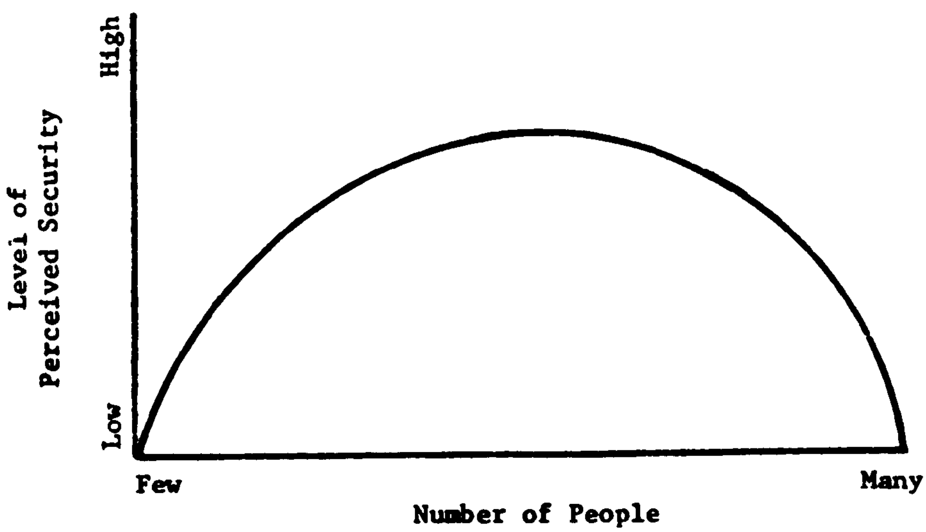
Familiarity and habit are probably associated with lack of concern for security. That is, perceived security will not be an issue to the habitual users of the system - using the system in normal ways. Familiarity will attenuate the effects of other variables: an old, dirty, but familiar transit station is probably more comfortable (and seen as safer) than a new, clean unfamiliar one. Security is not generally a concern when you are doing habitual things in familiar places.

The second set of psychological variables concerns the role of awareness, attention, or salience, in determining perceived security. First, there is the person's awareness of security as an issue. Prior work suggests that security is a greater concern for women, the elderly, and persons in poor health. Above, it was suggested that a person's awareness of or concern for security might depend on the familiarity of the surroundings: awareness of security may be more intense in unfamiliar situations.

Second, there is attention to or awareness of features of the environment. Feldman and Vellenga (1976) found that their panelists said various security measures would enhance their feeling of security, but they were unaware of measures already in use. A crime countermeasure will directly affect perceived security only if the user is aware of it. Part of a countermeasure strategy might be to focus user's attention on existent equipment and procedures and to make people aware of the function, operation, and consequences of extant countermeasures.

Social or interpersonal variables concern the other people present in the station. Here we must distinquish between official presence and other users. Perceived security will be enhanced by the presence in the transit station of transit employees and officials. A maximum level of perceived security will be provided by an armed police officer in the station close to the user. Police patrols will provide less perceived security because people don't perceive the frequency of police patrol, but only whether or not a policeman is in the station when they are.

How many other users are in the station and who they are also influences perceived security. An overly crowded station may cause insecurity as may one with too few people in it. A crowded station gives rise to crimes of aggression and assault as well as picking pockets and purse snatching. An environment with few people provides an opportunity for crimes like robbery, rape and mugging. Thus, there should be an optimal intermediate level of passenger density for which perceived security is at a maximum. Deviations from this optimal level in either direction would lead to lower levels of perceived security. Just what level of passenger density is optimal would depend on the transit station - its design and capacity. A function such as that below would summarize this relationship.



Furthermore, one's perceived security in a transit environment may depend on the extent to which the user perceives other users as being like himself. An old man will feel more secure in a station with other old people than with a group of teenagers. Various demographic and socioeconomic features of passengers could be used to define an index of similarity, but for our model, interpersonal situational variables will be limited to a measure of official presence and one of relative passenger density.

The third class of situational variable involves physical (spatial and temporal) considerations. One's level of perceived security will depend on time of day, length of wait in station (exposure time), whether the station is one's home station or a remote destination, and the extent to which the station is perceived to have effective crime countermeasures.

Perceived security depends on whether one is using the transit system at a peak or off peak period, whether it is day or night, and whether the time of day is a high or low tolerance period for the user.

Waiting time will be more problematic if it is unplanned than if it is planned. A user who knows how long it will be until the next vehicle arrives will be less insecure than one who is uncertain about when it will arrive. But any waiting time is exposure time and increases the risk of crime to the user. Short waits will insure greater perceived security and long waits less.

In addition to official presence (manpower), it is possible to enhance perceived security by appropriately selected and placed crime countermeasures. Shellow, Romualdi and Bartel (1974) assert that the key to perceived security is that the passengers feel that they can obtain help when it is needed. Feldman and Vellenga (1976) reported that their panelists favored certain types of countermeasures, especially communication and alarm devices.

Several papers dealing with transit security have included results from surveys in which people were asked what measures they thought would increase their feeling of security in a transit environment. In one report (TRI, 1975), activities were compared in terms of their actual and perceived security ranks. Perceived security was worst while entering and exiting the station; waiting for and riding the vehicle were perceived as relatively safe. Actual levels of risk are greatest when waiting for the vehicle and when riding it. The risk is less when entering or exiting the station. Thus those activities which need to be made more secure from an objective standpoint are not necessarily the ones the passengers think are dangerous.

Ferrari and Trentacoste (1974) asked their survey respondents to rank eight transit security improvements. The two most preferred improvements were "increasing the number of police at the stations" and "increasing the number of police on the vehicles." These were followed closely (in terms of mean ranks) by initiation of a communications network. The next two options were an alarm system and improved lighting.

A similar item was included in the Broad and Columbia Subway Development Study survey. Respondents rated the perceived personal safety they felt would result from each of a set of proposed security features. The highest rated alternative involved manpower—a full time security guard. A "platform level alarm system" and "closed circuit television monitoring of the platform area" were also highly rated. Design features (eliminating hidden corners, improving lighting, and open air design) were rated somewhat lower overall, but would still make significant improvements in perceived safety.

Shellow, Romualdi, and Bartel (1974) also report that increased police patrols of the stations and trains are perceived as the most effective security measures. In addition, they found that the knowledge that help could be quickly obtained in an emergency was essential to perceived security. They proposed an integrated system of crime countermeasures designed to enhance both actual and perceived security. The Teleview Alert system (TVA) incorporates CCTV cameras and monitoring equipment, emergency phones, TVA bars (alarm system), moveable barriers, and a public address system. The TVA system is being installed and evaluated on the Chicago Transit system. Its design emphasizes providing an effective link between the user of public transit and the appropriate security forces.

Our coding scheme for the situational variables is given below:

Situation Variables	Values	Scores
Familiarity	Familiar Station	
	Home	1
	Destination	2
	Unfamiliar Station	5
Use	Habitual Use	1
	Novel Use	3
Concern for Security	Low	1
	High	5

Situation Variables	Values	Scores
Party Size	Traveling Alone	5
	Accompanied	3
	In a Group	1
Passenger Density	Station Appears Empty	5
	A Few People Visible	
	As a Group	3
	Unassociated	2
	Moderate Density	1
	Crowded	5
Time of Day	Day - Peak	1
	Off Peak	3
	Evening - Peak	3
	Off Peak	5
	Night	7
Wait Time	Less Than 5 Min.	1
	5 - 10 Minutes	2
	10 - 15 Minutes	3
	15 - 30 Minutes	5
	Greater Than 30 Minutes	7
Uncertainty About Length of Wait	No	1
	Yes	5

A simple composite of the situation variables would result in a range of scores from 8 to 42 and means ranging from 1 to 5.25. Note that the situation composite is defined without either official presence or countermeasures included. For this model, official presence and countermeasures will be treated separately. They will be considered compensatory variables - their role involves reacting to or compensating for the situation in which crime is seen as a problem. The coding for each of these variables is given below:

Compensatory Variables	Values	Scores
Official Presence	Armed Police Visible	
	Constant	-2 *
	Regular	2
	Random	2
	Sporadic	3

Compensatory Variables	Values	Scores
Official Presence (Cont'd)	Other Employees	
	Ticket Sellers	2
	Maintainence Personnel	3
	No System Employees Visible	6
Countermeas··es	Constant CCTV Surveillance	1
	User Activated Monitor	3
	User Activated Alarms	3
	Audio Monitors	3
	Emergency Phones	3
	No Apparent Alarms or Communication Devices	6
Awareness of Countermeasures	Yes	1
	No	0

* Constant police presence is such a powerful countermeasure that it will overcome other undesirable features. To reflect its potency, we found it necessary to give its score a negative sign.

2.2.4 Expectations and Beliefs

Based in part on their direct perceptions and in part on indirect input, people develop beliefs and expectations about transportation systems in general and about specific aspects or features of such systems including crime and vandalism. First, people have ideas about the conditions for crime. They see it as more likely in certain contexts than in others. Certain attributes of physical and social situations are assumed to be associated with the occurrence of crime. Thus, some system features should relate to the degree to which an individual feels safe. Second, people have beliefs about the spatial distribution of crime. They have a cognitive map of their city, community, and the transportation system with certain areas or regions coded as safe and others as unsafe. Crime is seen as more likely to occur in certain places. Third, people have notions about the temporal distribution of crime. Crimes are assumed to be more likely to occur at certain times of the day, week, month, or year. The primary belief is that crimes occur most frequently at night. People feel safer in general at noon than at midnight.

Variables relating to each of the above kinds of belief have already been incorporated into the model. There is a more global set of beliefs or expectations concerning a transit system as a whole. A system will have a reputation in terms of its safety and security. This reputation will depend on its past history and on media coverage of the transit system. Media coverage can emphasize the general crime level of the transit system and influence the public's awareness of it. The media can influence people's awareness of security as an issue and also of security procedures and equipment. Thus, media coverage could create a negative impression of a system or a positive one--depending on what is reported and how.

If security is viewed as a problem, then visible active countermeasures will be necessary to reassure the public. In a system where safety and security is no problem, additional countermeasures probably won't improve perceived security. But if a problem exists, then compensatory action is necessary.

A score for general reputation of the system will be included in the model. It will be a single value ranging from 1 for a very secure system to 6 for a very insecure system. This parameter is primarily useful when one is interested in making comparisons across different systems. When comparisons are made within a system, this variable will be a constant.

In the study reported below, respondents to a survey indicated by checking a rating scale how secure they felt while using the transit system of their city. The mean rating taken over all respondents reflects the general reputation of the system.

2.2.5 Form of the Model

Implicit in the above exercise is a set of questions which must be answered to derive a viable model in any situation. By making those questions explicit we can see what must be done next. The questions are:

(1) What are you trying to model? What is the criterion of interest?

(2) What variables should be included in the model?

(3) How should each variable be quantified (measured, coded, or scored)?

(4) How should composite indices be formed to express components of the model?

(5) How should the components be integrated or combined into the overall model?

The criterion of interest is perceived security. Each user of the transit system is assumed to have some value on this variable--that is, some level of perceived security. The person feels safe or he doesn't. In the surveys described later in this report, users were asked to rate perceived security using a six point scale. The verbal descriptions and corresponding scores are:

Description	Score
Very secure	1
Secure	2
Somewhat secure	3
Somewhat unsecure	4
Unsecure	5
Very unsecure	6

This scale represents the criterion to be predicted by the model. The model must account for level of perceived security where that level varies from 1 to 6.

The previous four sections of the report describe the variables included in the model, an initial quantification of each, and the description of a composite variable for the person, station, and situation. For each of these three components, a composite is formed by simply averaging the values of all the relevant variables. The component is conceived of as a "commodity bundle,"--it is described as a set of features all of which have values in any application. That is, every station is described by values on all station variables--no variable can be missing or irrelevant.

Of course, the composite variables could be formed in several ways. Instead of a simple average of the variables, a weighted average could have been used. Further, interactions, cross products and nonlinear combination rules might have been introduced. However, one goal of modeling is to simplify a complex situation so that its essential components and relations can be seen and understood. We decided to start with a very simple model and complicate it if the data, subsequently collected, warranted the added complexity.

The final question is how to integrate these components. In forming an impression of security, an individual takes account of the person (himself, herself), the station, the situation, the general reputation of the system, and the compensating factors. A diagram of the variables involved is presented in Figure 4. These components could be related (mathematically) in several ways.

In our model, a simple average is formed of the composites for person, station, situation, and expectations; this average is called the Initial Security Impression (ISI).

Thus

$$ISI = (\bar{X}_p + \bar{X}_{stn} + \bar{X}_{sit} + X_{rep})/4 \quad (1)$$

where

$\bar{X}_p$ = mean score on user component

$\bar{X}_{stn}$ = mean score on station component

$\bar{X}_{sit}$ = mean score on situation component

X_{rep} = system reputation rating

The initial security impression is a simple average of the composite variables describing the user (section 2.2.1), the station (section 2.2.2) and the situation (section 2.2.3) and the simple variable reflecting the general system reputation (section 2.2.4). It depends on all of the features of the user, the station, and the situation which were described above.

Depending on whether the initial security impression is good or bad, the individual may seek evidence that the transit authority has

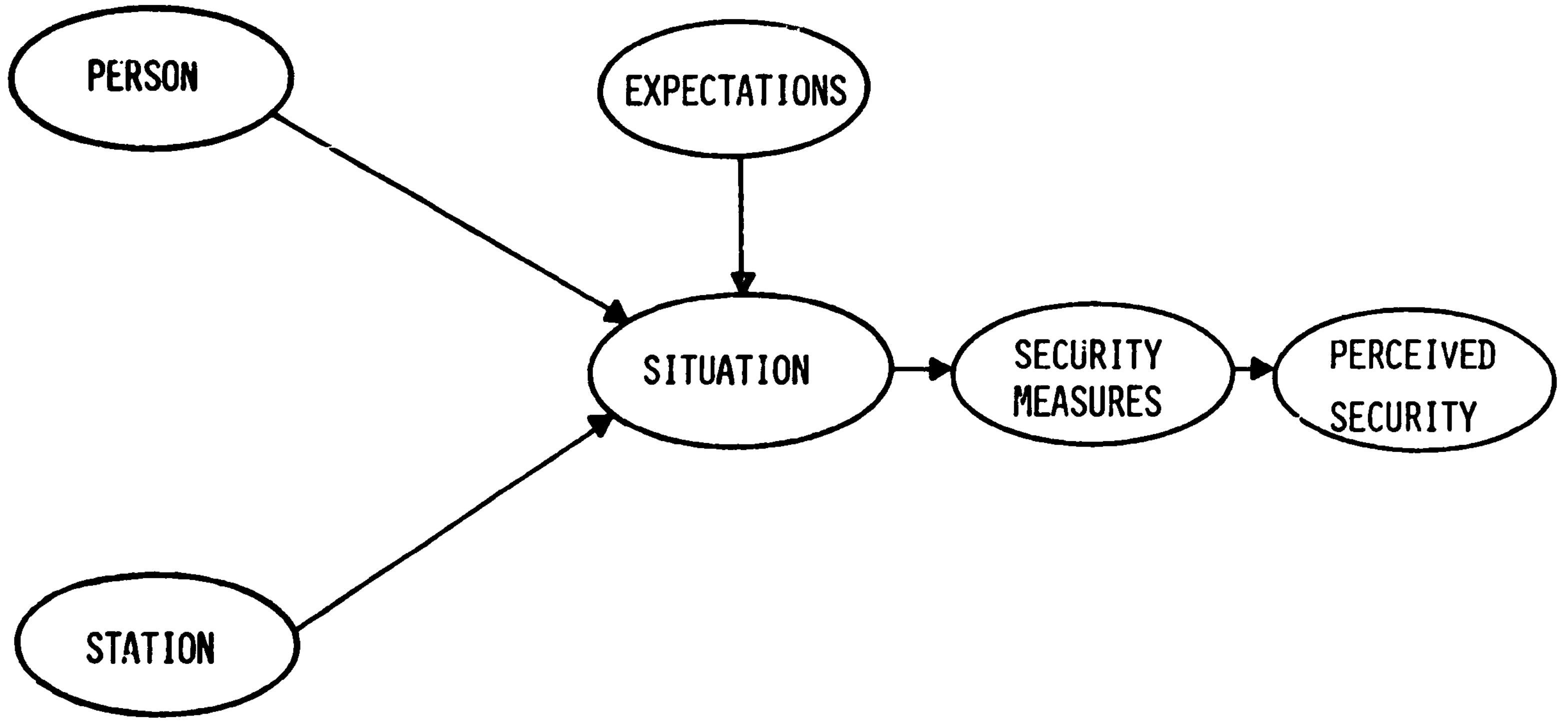


Figure 4. Components of a Model of Perceived Security

provided for passenger security. A security response (SR) may be either official presence (manpower) or crime countermeasures. The model involves a security response component defined as

$$\text{Security Response (SR)} = \begin{cases} -2 \text{ if armed police present} \\ \\ (X_{o.p.} + W_a X_{cm}/2 \text{ otherwise} \end{cases} \qquad (2)$$

where

X_{op} = official presence score

X_{cm} = countermeasure score

W_a = awareness of countermeasures score (yes = 1, no = 0).

Equation 2 says that if armed police are present, the security response is very good (-2 is much better than +1, where + 1 means very secure). This level of security response may compensate for (overcome) undesirable features of the station or situation. If armed police are not present, then the security response is defined as a combination of official presence and crime countermeasures variables. The values and scores for these variables were presented in section 2.2.3. In order for the presence of countermeasures to influence the users' sense of security, they must be aware of those countermeasures. The multiplier, W_a, reflects this awareness or lack of it. If the user is unaware of the countermeasures, $W_a = 0$ and the whole term $W_a X_{cm}$ drops out of the equation. The security response would then depend solely on official presence.

Thus, the need for a security response is predicated on a certain level of insecurity and the user's perception of the security response

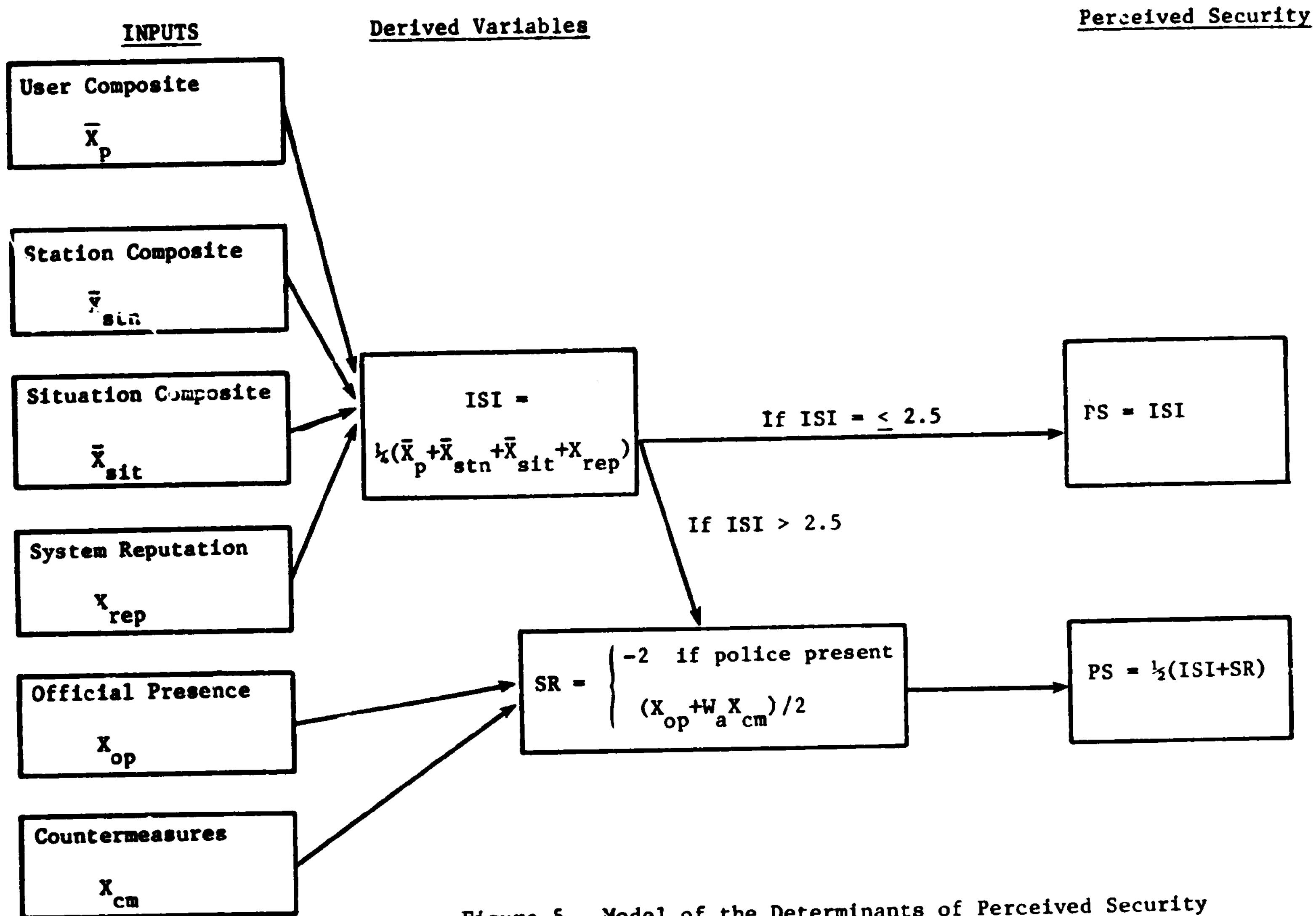


Figure 5. Model of the Determinants of Perceived Security

depends on whether armed police are present and whether the user is aware of the crime countermeasures. These conditions are reflected in the final two equations of the model:

If ISI $\leq$ 2.5, then PS = ISI. (3)

If ISI > 2.5, then PS = $\frac{1}{2}$ (ISI + SR) (4)

If the computation of equation 4 results in a numerical value less than one that value is set equal to one.

The model of perceived security is given by equations 1, 2, 3 and 4 and by the formation rules for the composites entering into equation 1. A diagram of the relations of all the components of the model was given in Figure 4; a more precise picture, with the mathematical details, is presented in Figure 5. This figure shows our second type of model - a model of the determinants of perceived security.

2.2.6 Consequences of the Model

Several assumptions and implications of the model of perceived security should be made explicit. Since they are simple averages, the component scores for the user, station, and situation are influenced by all the variables in the component. Variables can to some extent compensate for each other; good features can balance out bad ones. The worse the score on any variable, the worse the component score. Bad scores on several variables cause the component score to be worse than bad scores on only one or two.

To show how the component scores are influenced by the variables several examples are presented for each component:

User Component:

Case 1:	Young man in good health, frequent user.	$\bar{X}_p = 1.0$
Case 2:	Middle aged man in good health, frequent user .	$\bar{X}_p = 1.5$
Case 3:	Older woman in good health, frequent user.	$\bar{X}_p = 2.5$
Case 4:	Older woman in poor health, infrequent user.	$\bar{X}_p = 4.5$

Station Component:

Case 1:	Bright, new, clean, well maintained, non-obtrustive, good visibility, in low crime area.	$\bar{X}_{stn} = 1.0$
Case 2:	Bright, old, clean, well maintained, non-obtrustive, some obstructions, in high crime area.	$\bar{X}_{stn} = 2.43$
Case 3:	Bright, old, dirty, poorly maintained, noticeable (sensory aggravation), some obstructions, in high crime area.	$\bar{X}_{stn} = 4.43$
Case 4:	Very poor lighting, old, dirty, poorly maintained, annoying, limited visibility in high crime area.	$\bar{X}_{stn} = 6.14$

Situation Component:

Case 1:	Home station, habitual use, low concern, traveling alone, moderate user density, day - off peak, short wait, no uncertainity.	$\bar{X}_{sit} = 1.75$
Case 2:	Unfamiliar station, novel use, low concern, accompanied, moderate density, evening - off peak, short wait, no uncertainty.	$\bar{X}_{sit} = 2.5$
Case 3:	Familiar destination, novel use, high concern, alone, crowded, day - peak, long wait, uncertain.	$\bar{X}_{sit} = 4.125$
Case 4:	Unfamiliar station, novel use, high concern, alone, station appears empty, night, long wait, uncertain wait.	$\bar{X}_{sit} = 5.25$

For the compensatory variables, it is assumed that manpower and official presence are averaged together to gain a security response impression. However, this impression is irrelevant if (a) the initial security impression is good ($\geq$ 2.5), and (b) if an armed police officer is near and visible in the station. We assume that an armed official presence is the best countermeasure and that the presence of such a police officer makes all other countermeasures irrelevant. If police are present, even a bad situation will be markedly improved in terms of perceived security.

But lacking an armed police officer in the station, official presence and countermeasures are assumed to be able to balance each other. However, if a user is unaware of the crime countermeasures, they will not influence perceived security.

If a situation is perceived as somewhat risky or bad, then the absence of employees or countermeasures will make it worse.

Further implications worth noting are: (1) variables differ in how widely spread the values they may assume are - this does provide a sort of differential weighting, (2) the reputation of the transit system is assumed to be a component on par with the person, station, and situation components, and (3) the security response variable is weighted equally with the initial security impression - if security is a problem.

Several computed values for the whole model are shown below. Component means are used rather than listing complete sets of variables that could give rise to those means.

$\bar{X}_p$	$\bar{X}_{stn}$	$\bar{X}_{sit}$	X_{rep}	X_{op}	X_{cm}	PS
1.0	1.0	1.0	2.5			1.375
2.5	2.43	1.75	1.5			2.045
2.5	2.43	4.125	3.5	-2		1.139
2.5	2.43	4.125	3.5	6	6	4.569
2.5	2.43	5.25	4.0	6	1	3.52
4.5	6.14	5.25	4.0	2	6	4.486
4.5	6.14	5.25	4.0	-2		2.9725

Several aspects of this model will be tested in the experiment and surveys discussed in the next two sections. However, much more extensive experimentation will be necessary to explore all of the interesting aspects of this model of perceived security.

3. THE EXPERIMENT AND SURVEYS

This study is part of a comprehensive project on system safety and passenger security for AGT systems. One task was to develop a model of perceived security. Another was to evaluate an experimental crime countermeasure which was appropriate for an AGT system. A test of an AGT relevant countermeasure was designed so as to also test features of the models of perceived security discussed above.

In the experiment, the selected countermeasure was installed in one of two specially chosen transit stations. Surveys were conducted at both stations - both before and after installation of the countermeasure. These surveys assessed various parameters of the two types of models. The surveys were designed to test the models and the effects of the countermeasure on perceived security at the experimental site.

3.1 Selection of the Countermeasure

A target countermeasure would have to be (a) feasible for use in current transit systems--it is to be implemented and tested on an already operating system, (b) likely to effect perceived security, and (c) relevant to an AGT application--in particular, the countermeasure must integrate with a totally automated system and must involve low manpower requirements.

Two kinds of prior work are relevant to selecting a target (test) countermeasure: first are studies of the actual effectiveness of countermeasures; second are studies of user perceptions of countermeasures and their effectiveness. Few studies of the actual effect of countermeasures on transit crime have been done. What information does exist has been summarized in the report on Task I for this contract. Some information from that report is reviewed below. An earlier section of the present report discusses what is known about user perceptions of crime countermeasures (see Section 2.2.3).

3.1.1 Countermeasure Evaluation: University of Virginia Panels

A panel of ten judges was established to help evaluate crime countermeasures. There were six men and four women on the panel. Several participants were well acquainted with issues and procedures regarding transit security; some others were familiar with transportation research but not experts on security; others were unfamiliar with research in this area. All had some familiarity and experience with at least one major metropolitan transit system.

These panelists were asked to make three kinds of judgments concerning crime countermeasures. First, they were asked to consider a set of countermeasures in relation to various crimes of several types. For each crime, they were asked to decide whether the countermeasure would have any effectiveness against the crime, and if so whether the effectiveness would be great or moderate. Second, they were asked to consider the acceptability of each countermeasure (1) to the transit rider and (2) to the transit operator, and to rate whether "acceptance costs" were high, medium or low. A countermeasure with high acceptance costs would be one that is objectionable and not likely to be acceptable. Low acceptance costs are good from the perspective of the user or operator. Third, panelists were asked to rate the relative monetary costs of the various countermeasures, separating capital from operating costs. Such costs were simply rated high, medium, or low in each case.

All three kinds of judgments provide only ordinal data, and the method of pooling or aggregating this data was by "consensus judgment." That rating which was given by the most panelists was taken as the consensus or decision of the group for any given judgment. There was usually agreement among the panelists; 8 or more of the 10 agreeing on a particular rating. The results of these procedures are shown in Tables 2 and 3. These tables are tentative and are subject to further testing and refinement. They are however quite informative as they stand and indicate some general conclusions important to this study.

Table 2 shows the judged effectiveness of various countermeasures against particular crimes of several types. An "x" means that the countermeasure would be very effective against the crime, a "/" indicates moderate effectiveness, and an "o" no effect. Most countermeasures have moderate effectiveness for several crimes and strong effectiveness for only one or two. However, some countermeasures seem to be very effective against a wide array of crimes. There are (1) a visible, uniformed security force, (2) closed circuit television (C.C.T.V.), (3) K-9 patrols (police officer with a dog), (4) presence of transit personnel, and (5) saturation patrols. All but one of these uses extensive manpower (personnel) for its effect. The use of closed circuit television is the only low manpower countermeasure with general effectiveness. It still requires manpower, of course, but significantly less than the other options. The primary manpower requirements are for screen monitors and a response force.

TABLE 2

JUDGMENTS OF COUNTERMEASURE EFFECTIVENESS

	CRIMES	GOOD LIGHTING	"OPEN" DESIGN	CLIMATE CONTROL	ADAPTIVE SPACE	VISIBLE, UNIFORMED SECURITY FORCE	MEDIUM-VOLUME TRAFFIC FLOW	SCHOOL/COMMUNITY PROGRAMS	ATTRACTIVE, CLEAN TRANSIT PROPERTY	REDUCE NO. OF CARS DURING OFF-PEAK HOURS	PRE-SCREEN RIDERS	ELIMINATE STATION RESTROOMS	TRANSLUSCENT DOORS IN RESTROOMS	PNEUMATIC TUBES TO COLLECT END-OF-DAY RECEIPTS	VOICE MONITORS	CCTV	PASSENGER-ACTIVATED ALARMS	ALARM-ACTIVATED VIDEO-TAPE
AGAINST PERSON	ASSAULT	/	/	/	/	X	/	0	0	/	/	0	0	0	/	X	/	/
	BATTERY	/	/	/	/	X	/	0	0	/	/	0	0	0	/	X	/	/
	HOMICIDE/ MANSLAUGHTER	/	/	/	/	X	0	0	0	/	/	0	0	0	/	X	/	/
AGAINST PERS. CARRIED PROP	ROBBERY	X	X	/	/	X	/	0	0	/	/	/	/	0	/	X	/	/
	PURSE-SNATCHING	/	/	0	/	/	0	0	0	0	/	/	0	0	/	X	/	/
	POCKET-PICKING	/	/	0	/	X	0	0	0	0	/	0	0	0	0	/	/	/
AGAINST STATION PROP.	STATION BURGLARY	/	X	0	0	X	/	0	0	0	/	0	0	X	/	X	/	/
	FARE EVASION	/	/	0	/	X	/	/	0	0	X	0	0	0	0	X	0	/
	VANDALISM	/	/	0	/	X	/	/	/	/	/	/	/	0	/	X	/	/
	PETTY THEFT	/	/	0	/	X	0	/	0	0	/	0	0	0	0	X	/	/
	TRESPASSING	/	0	0	/	X	0	0	0	0	/	0	0	0	/	X	0	/
	ARSON	/	/	0	0	X	/	0	0	0	/	0	0	0	0	X	/	/
	MISSILINGS	0	0	0	0	X	0	/	/	0	0	0	0	0	0	/	0	0
AGAINST PUBLIC	DRUG LAW VIOLATIONS	/	/	0	/	X	0	0	0	0	X	X	/	0	0	/	0	0
	SEX CRIMES	X	/	0	/	X	/	0	0	/	/	/	/	0	/	X	/	/
	DRUNKENNESS	0	0	0	0	/	0	0	0	0	X	/	0	0	/	0	/	/
	DISORDERLY CONDUCT	/	/	0	/	/	/	0	0	/	/	0	0	0	/	X	/	/
	CONCEALED WEAPONS	0	0	0	0	/	0	0	0	0	X	0	0	0	0	0	0	0

	CRIMES	BURGLAR-TYPE ALARMS	PUBLIC ADDRESS SYSTEM	TELEVIEW ALERT SYSTEM	METAL DETECTORS	K-9 PATROLS	PRESENCE OF TRANSIT PERSONNEL	PLAIN-CLOTHES DETECTIVES	SATURATION PATROLS	POLICE DECOYS	NON-SCHEDULED TRAIN STOPS	AERIAL PATROLS	NON-BREAKABLE WINDOWS	VANDAL-PROOF SEAT COVERINGS	CLEANABLE, GRAFFITI-PROOF SURFACES	AUTOMATICALLY SEALED EXITS	SINGLE EXITS	PREVENTION OF FARE EVASION
AGAINST PERSON	ASSAULT	0	/	/	/	X	X	/	X	/	/	0	0	0	0	/	/	0
	BATTERY	0	/	/	/	X	X	/	X	/	/	0	0	0	0	/	/	0
	HOMICIDE/ MANSLAUGHTER	0	0	/	/	X	X	/	X	/	/	0	0	0	0	/	/	0
AGAINST PERS. CARRIED PROP	ROBBERY	0	/	/	/	X	X	/	X	X	/	0	0	0	0	/	/	/
	PURSE-SNATCHING	0	/	/	0	X	X	/	/	/	0	0	0	0	0	/	/	/
	POCKET-PICKING	0	/	/	0	/	X	/	X	/	0	0	0	0	0	/	/	/
AGAINST STATION PROP.	STATION BURGLARY	X	/	X	/	X	X	/	X	/	0	0	0	0	0	/	/	/
	FARE EVASION	X	/	/	0	X	X	/	X	0	0	0	0	0	0	/	/	X
	VANDALISM	/	/	/	0	X	X	/	X	0	0	/	/	/	/	/	/	/
	PETTY THEFT	/	/	/	0	X	X	/	X	0	0	0	0	0	0	/	/	0
	TRESPASSING	X	/	/	0	X	X	/	X	0	0	/	0	0	0	/	/	0
	ARSON	X	/	/	0	X	X	/	X	0	0	0	0	0	0	/	/	0
	MISSILINGS	0	0	0	0	/	/	/	/	0	0	/	0	0	0	0	0	0
AGAINST PUBLIC	DRUG LAW VIOLATIONS	0	0	/	0	X	/	/	X	/	0	0	0	0	0	/	/	0
	SEX CRIMES	0	/	/	0	X	X	/	X	X	0	0	0	0	0	/	/	0
	DRUNKENNESS	0	0	/	0	/	/	/	/	0	0	0	0	0	0	0	0	0
	DISORDERLY CONDUCT	0	/	X	0	/	/	/	X	0	0	0	0	0	0	0	0	/
	CONCEALED WEAPONS	0	0	0	X	/	/	/	/	0	0	0	0	0	0	0	0	0

* X = very effective against the crime, / = somewhat effective, 0 = no effect.

TABLE 3

JUDGMENTS OF ACCEPTANCE AND MONETARY COSTS OF COUNTERMEASURES

COUNTERMEASURE	Acceptance Costs: Objectionable to Transit Riders	Acceptance Costs: Objectionable to Transit Operators	Monetary Costs: Capital Costs	Monetary Costs: Operating Costs
Pre-Screen Riders	H	H-	M+	H
Alarms & Sensors	L	L	M	M
CCTV	L	L	M	M
Voice Monitors	L+	L	M	M
Barriers	L+	L	M	L
Sealed Exits	M	L+	L+	L
Fare Box Hardening	L	L	M	L
Good Lighting	L	L	M	L+
Open Station	L	L	M	L
Climate Control	L	L	M	M
Adaptive Space	L	L	M	L+
Attractive Environment	L	L	M-	M
Restroom Restrictions	M+	L+	L	M-
Single Exits	H	L	L	L
Community Relations	L	M-	L	M
Police Patrols	L	L	L	H
Vehicle Deployment Strategies	L	L	M-	M
Canine Patrols	L+	M-	L+	H
Aerial Surveillance	L	M	H	H
Reduced Service	H	L+	L	L
Legal Sanctions	L	L+	L	M+
Land Use Considerations	L	M		L
Teleview Alert System	L	L	H	M

H = high M = medium L = low/little
+ better, - worse

Table 3 summarizes the panelists evaluation of the acceptance and monetary costs of various countermeasures. Thus, police patrols have low acceptance costs, low capital costs, but high operating costs. CCTV has low acceptance costs, high initial capital costs and moderate operating costs. Reduced service and single exits are rated highly objectionable to users. Prescreening riders is objectionable to both users and operators.

Closed circuit television is thus considered highly effective against a wide range of crimes, acceptable to the transit user and operator and, while having high initial costs, it has moderate operating costs. It is also an ideal countermeasure for AGT applications since it would be appropriate for use in unmanned terminals and vehicles. So, CCTV is the ideal countermeasure to investigate for this study--given that its goals are to assess the effects on perceived security of a countermeasure appropriate to AGT systems.

3.1.2 PATCO Pilot Study

A small-scale pilot study was undertaken to explore preliminary hypotheses about perceived security and to pretest possible formats for questionnaire items. A panel of 30 respondents (mostly students and acquaintances) were employed to provide information regarding perceived security on a major urban rapid rail system (PATCO). PATCO is a modern system with many high technology components. It is similar in some respects to proposed AGT systems.

The panelists ranged in age from 17 to 49, with a mean age of 25 and a median age of 20. Twelve members were male, eighteen female.

Most panelists said they used the PATCO system occasionally; 8 respondents used it daily or weekly. Social-recreational reasons were the most frequently reported trip purpose; with trips for shopping and to work or school also often cited.

The respondents rated the PATCO system as "good" on all of a set of system features, including cost, convenience, scheduling, reliability, cleanliness, comfort, service, accident safety and personal security. These ratings varied from 1.97 (scheduling) to 2.73 (cost) on a 6 point scale with a rating of 1 as very good and 6 as very bad. The attribute rating for personal security on PATCO was 2.47, with 18 of the 30 responses being 2 (= "good").

Another item asked again for a rating of personal safety and security on the PATCO system. Sixteen panelists rated the system "safe," eleven "somewhat safe," and one "very safe;" only two panelists felt it was at all dangerous.

Thus, on two separate items, almost all of the panelists rated the PATCO system as a whole safe and secure. However, 2/3 of them identified parts of the system (areas of town, terminals, or routes) they would avoid for reasons of personal security, and over 1/2 expressed reluctance to use the system at night. When they were asked to rate the safety and security of different places and times as part of a trip, (1) the area in and around the home station was rated more safe than on the train which in turn was more safe than the area in and around the destination station, and (2) dav times were rated safer than night. Thus, how safe a person feels depends on where in the transit system they are and when they are using the system.

These panelists were asked which of a list of possible occurrences or incidents they were aware of or had witnessed occurring in the PATCO system. The most common offenses reported were fare evasion, public drunkeness, pushing and shoving on or around trains, disorderly conduct, and drug use. No one reported witnessing any serious crimes against persons, and few people had seen crimes against personally carried property. There were also a few reports of witnessing vandalism and graffiti production.

One question for the panel dealt with the use of an alarm system; 2/3 of the panelists felt they would activate an alarm system if they witnessed a crime in progress; seven panelists said they didn't know, and one said probably not. Another question was asked on whether the panelists believed that when riding the PATCO system, there were people available who could help if an emergency happened: 17 said yes, 13 said no. The panelists indicated who they thought would help or would be willing to help. Sixteen panelists felt other passengers would help, 25 thought PATCO employees would and 27 thought the police would. Thus more panelists have confidence in the police and transit personnel than in other passengers.

When asked to react to various proposed means of improving safety and security, the panelists gave the responses summarized in Table 4. The proposed countermeasures are arranged from those with greatest perceived value to those with least. The five most preferred countermeasures are two involving manpower, two involving communications, and improved lighting in the stations. Most people say they would probably or definitely feel safer as a result of closed circuit television and/or

TABLE 4

PATCO SUBJECT REACTIONS TO COUNTERMEASURES

Countermeasure	Definitely Feel Safer	Probably Feel Safer	No Change	Feel Less Safe
Random Police Patrols	.47	.50	.03	0
More Accessible Alarm Systems	.37	.60	.03	0
More Lighting In Station	.43	.50	.07	0
Emergency Phones	.33	.60	.07	0
Police With Dog Patrol	.40	.33	.07	.20
Fare Payment to Enter Station	.17	.57	.26	0
Closed Circuit Tele-vision	.23	.47	.30	0
Electronic Surveillance	.13	.47	.40	0
Alarms Which Seal Exits	.10	.43	.40	.07
User ID Passes	.10	.37	.50	..03
First Class Section on Vehicles	0	.47	.53	0
Higher Speed Vehicles	.11	.30	.37	.22
Complete Computer Control of Trains	.03	.24	.60	.13
Few or No Employees in System	.03	.03	.14	.80

electronic surveillance. Thirty percent say they would experience no change in their felt level of security as a result of CCTV--these responses are ambiguous since PATCO in fact uses CCTV. The respondents may or may not be aware of that fact, and the interpretation of the meaning of their answer depends on whether they were or not. But 70% of the respondents felt they would probably (or definitely) feel safe with CCTV in the system.

PATCO is a high technology system, but most respondents report that they would feel less safe as a result of few or no employees in the system. This is not simply a fear or distrust of technology--notice that only 13% of the panelists would feel less safe with complete computer control of the trains and several technological countermeasures are rated high in the list.

This preliminary information was used to refine the questionnaire for the actual study reported in detail below. It also provided further support for the notion that CCTV was perceived as an effective countermeasure for use in public transportation.

3.1.3 <u>Relevance to AGT</u>

Features of the passenger value structure model are to be tested in a context relevant to AGT systems. Several characteristics of proposed AGT systems raise issues of actual and perceived security. The system is to be <u>totally automated</u>; vehicle operation, ticket sales, information and passenger processing will all be done by machine. There will be <u>no employees</u> in the vehicle or stations under normal circumstances. This lack of employee presence may lead to perceptions of decreased security by passengers. Various devices and equipment are necessary to assume the functions usually performed by people in a transit environment. Such devices themselves may be targets for abuse and vandalism.

Clearly, there must be ways to communicate with human decision makers at a remote location. Closed circuit television, perhaps coupled with alarms and/or audio monitoring capability, would seem an ideal countermeasure for AGT environments. CCTV is a reasonable effective countermeasure; it involves minimal manpower; and it integrates well with AGT system components and with the general AGT philosophy. Other effective countermeasures generally involve extensive manpower.

3.2 Site Selection

Several criteria were involved in selecting the transit system on which the experiment was conducted:

(1) There had to be some crime in the system.

(2) There had to be parts of the system for which the level of perceived crime was high, whether or not actual crime levels were.

(3) It had to be possible to realize a low manpower situation at the site of the experiment. All AGT systems have as a basic premise low levels of manpower; few employees or security personnel will be on the vehicles or in the stations. It would be unrealistic to do an experiment relating to AGT systems in a situation which relies on high manpower involvement for safety and security.

(4) Given that a suitable target station could be found, a second station similar to the first had to be available to act as a control site.

(5) The security force protecting the transit system had to be cooperative and interested in the experiment.

The New York City transit system was found to meet all of the above requirements. The security force officials were very cooperative. They were able to find two stations very similar in physical features and social conditions: one for an experimental station, the other for a control. Both stations have low levels of actual crime, but the target (experimental) station was perceived by members of the community to have a crime problem. The manpower available for the target station could be deployed to monitor the closed-circuit television equipment, thus creating low employee density in the station while maintaining surveillance and response capability. Officers monitoring the television screens were located at a police substation adjacent to the station area. Thus, this transit system was ideal in terms of our ability to realize the necessary experimental conditions in a low manpower situation. The system was an older and very extensive one serving a relatively large metropolitan area.

Two stations were selected as targets for this research. An experimental system modification, the installation of closed-circuit television monitoring, occurred at one station; a second station was used as the control site. These two areas closely resembled each other--both in terms of the physical layout of the stations and the characteristics of the surrounding communities (see Table 5). Both stations are the terminal points for their lines, both are at street level, and each

TABLE 5

AGT PROJECT--SECURITY EXPERIMENT

Comparative Features of The Experimental Site (Beach 116th Street, Rockaway Park) and the Control Site (Rockaway Parkway)

	Features	B. 116th Street Station	Rockaway Parkway Station
a.	Role in experiment	Experimental Site	Control Site
b.	Station elevation and entry	Street level	Street level
c.	Station components	Large waiting room, large outside ramp, one outside platform with roof	Small waiting room, small outside ramp, one outside platform with roof
d.	Station type	Terminus of Rockaway Line	Terminus of 14th Street - Canarsie Line
e.	Neighborhood	Residential with small stores, middle class	Residential with small stores, middle class
f.	Adjacent neighborhood along train route	Higher crime, "ghetto" area	Higher crime, "ghetto" area
g.	1970 U.S. Census Tracts around the station	Nos. 0922, 0928, 0934	Nos. 0962, 0964, 0966, 0968, 0970, 0974, 0988, 0990, 0992
h.	Total population in census tracts (1970)	14,421	15,096
	Negro (%)	50 (0.35%)	53 (0.35%)
	Spanish Speaking (%)	129 (0.89%)	459 (3.04%)

Table 5 (continued)

Features	B. 116th Street Station	Rockaway Parkway Station
i. Age Group(s) (selected)		
15-19 years (% of total)	1111 (7.70%)	1211 (8.02%)
25-34 years (% of total)	1293 (8.97%)	1715 (11.4%)
45-54 years (% of total)	1934 (13.4%)	2227 (15.1%)
65-74 years (% of total)	1751 (12.1%)	1060 (7.02%)
j. No. of Workers (% of all persons)	5267 (36.5%)	6274 (41.6%)
k. Workers using subway or elevated train (% of all workers)	1252 (23.8%)	2901 (46.2%)
l. High School and College Students (% of all persons)	1586 (11.0%)	1357 (9.0%)
m. Mean 1969 family income (No. of families)	$18,402.(3915)	$10,568. (4330)
n. No. of all year-round housing units	5360	5033
o. Actual crime level	Low	Low

serves an identifiable geographic area. Both areas contain primarily middle-class, single-family dwellings. In both cases, the subway line passes through a ghetto area before reaching the target neighborhoods.

3.3 Survey Plan

Surveys were distributed to randomly selected households in the areas surrounding two transit terminals. The terminals had been selected for physical similarity, location, and the socio-economic characteristics of surrounding neighborhoods. At one terminal (the experimental station), changes in security procedures and equipment were instituted with appropriate media coverage: a closed circuit television system (CCTV) was installed to monitor the platform and station areas. At the control station, no changes were made.

Questionnaires were distributed to households selected according to census tract information and demographic characteristics, so as to represent a wide range of income levels and ages, and equal numbers of men and women. Mail surveys were feasible in both areas--since they have well-defined geographic limits, and census tract information was available for both. There are about 15,000 people in each neighborhood. Each potential respondent could receive up to four (4) mailings: an initial postcard or letter alerting him to the fact that a survey is coming; the questionnaire itself; and two follow-up contacts, as needed, for those who did not respond to the initial survey within two weeks. Samples of the four letters are included in Appendix A. An overview of the data acquisition plan is shown in Figure 6. The same

T1	T2	T3
PRETEST	EXPERIMENTAL SYSTEM CHANGE	POST TEST (AFTER SYSTEM CHANGE)
TARGET STATION SURVEY USERS SURVEY NONUSERS	INSTALL CCTV	SURVEY USERS SURVEY NONUSERS
CONTROL STATION SURVEY USERS SURVEY NONUSERS	NONE	SURVEY USERS SURVEY NONUSERS

Figure 6. Plan of Study

questionnaire was administered both before and after the experimental modification of the target transit station. The baseline (pretest) survey was completed before any security changes were initiated or announced. The immediate reaction (post test) survey was started shortly after new equipment was installed and press coverage announced its existence and potential benefits. In both surveys, the target population included both users and nonusers and various levels of sex, age and income. The two surveys were sent to randomly and independently selected samples. The same people were not necessarily involved, but it is possible that some respondents were included in both surveys.

The questionnaire was designed to assess several facets of perceived safety and security. The basic types of information requested are shown in Figure 7. Items were included to assess experiences with crime and vandalism, feelings of security as a function of time and place in the transit system, and perceptions of various aspects of the system and its operation. Other types of items asked for demographic information, system use patterns, and the availability of personal vehicles. A copy of the questionnaire is included in Appendix A of this report.

In general, there were two distinct classes of survey items: those that should (or might) be responsive to experimental changes in the transit system and those that should be unaffected by such changes. The latter questions provide the basis for assessing the comparability of two samples. Very specific hypotheses were formulated about which items should reflect experimental changes. Basically, users of the experimental station should perceive it as safer after the announced changes, but their perceptions should not change regarding some other terminal which remains

1. DEMOGRAPHIC CHARACTERISTICS

   AGE, SEX, SOCIOECONOMIC STATUS, ETC.

2. USE OF SYSTEM

   FREQUENCY; REGULARITY; DISTANCE TRAVELED,
   ALTERNATIVES AVAILABLE? CONSIDERED?

3. EXPERIENCE WITH CRIME AND VANDALISM

   DIRECT—INVOLVED; WITNESSED; SEEN RESULTS.
   INDIRECT--MEDIA, ADS, FRIENDS, ETC.

4. PERCEPTIONS

   AWARENESS OF SYSTEM FEATURES AND OPERATING PROCEDURES.
   AWARENESS OF CRIMES, ACCIDENTS, DELAYS, ETC.

5. BELIEFS

   CONDITIONS FOR CRIME.
   SPATIAL DISTRIBUTION OF CRIME.
   TEMPORAL DISTRIBUTION OF CRIME.

6. EVALUATIONS

   PROBABILITY OF CRIME OR ACCIDENT INVOLVING SELF.
   FEELING OF SAFETY, SECURITY.
   FEARS OF CRIME, ACCIDENT, MISHAP.
   SATISFACTION WITH SYSTEM.
   ATTRACTIVENESS OF SYSTEM.

Figure 7. Passenger Survey Information

unchanged. Respondents in the area around the control station should not change their perceptions either of their home terminal or of a second selected terminal. In the discussion below, the local or home station differs for experimental and control respondents, but the remote terminal is the same for both. It is a well known, central business district terminal accessible from both home terminals.

4. RESULTS

4.1 Demographic Information

The basic demographic information for the two samples is summarized in Table 6. The samples do not differ appreciably from each other in any respect. However, there are some differences between the distributions of women and men within each sample. There are more women than men in the younger age levels, and the reverse is true for the older ages. There is a slight overrepresentation of women in the lower income categories. In general, however, a reasonable distribution of sex, income and age was found in the two samples, with no strong interdependencies of the three variables. Whenever the proportions don't add to 100%, some respondents failed to answer that particular item.

Most respondents had drivers' licenses, although somewhat more men did than women; and most considered themselves to be frequent drivers (see Table 7). About 75 percent of all respondents had one or two personal vehicles available in their households. In both samples, about 20% of the women had no personal vehicle in their households, as compared to 14% of the men. Thus, circumstances would seem to indicate that slightly more women than men would need to use public transportation.

4.2 Patterns of Transit System Use

Figure 8 shows the distribution of the frequency of system use for respondents in the two survey waves. For later analyses, those respondents have been classified as frequent and infrequent users and nonusers. About 50 percent of each sample are frequent users, while 14 percent of each are nonusers.

TABLE 6

BASIC DEMOGRAPHIC INFORMATION

	Survey 1		Survey 2	
	Male	Female	Male	Female
N	352	389	387	363
Age (in years)				
30 or less	19%	33%	19%	31%
31 - 59	48%	46%	50%	46%
60 or older	33%	21%	31%	23%
Income				
under $5,000	3%	10%	4%	7.5%
$5,000-9,999	10%	16%	8%	13%
$10,000-14,999	19%	20%	16%	18%
$15,000-19,999	20%	15%	23%	22.5%
$20,000-24,999	19%	14%	18%	12%
$25,000-29,999	11%	10%	11%	12%
$30,000-34,999	7%	7%	5%	6%
$35,000 and up	10%	8%	15%	8%

TABLE 7

AVAILABILITY OF AUTOMOBILES

	Survey 1		Survey 2	
	Men	Women	Men	Women
Have Operator's License	88.5%	66%	88.9%	70.3%
Frequent Driver	68.5%	73.5%	78%	63.8%
Number of Personal Vehicles in Household:				
None	14.5%	20.3%	12.9%	19.3%
One	55.2%	48.4%	55.3%	50.3%
Two	24.4%	27.7%	28.2%	26.8%
Three	4.7%	2.7%	3.0%	3.0%
Four or more	1.2%	.8%	.5%	.6%

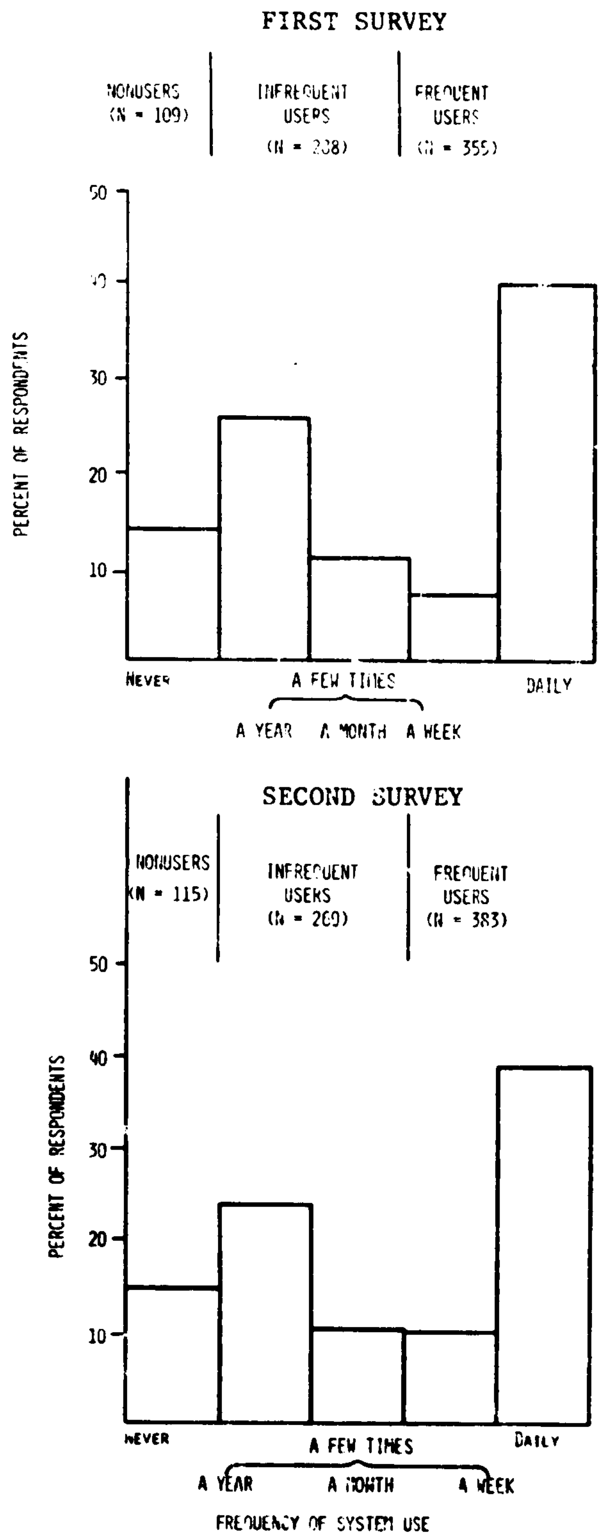


Figure 8. Distribution of Respondents by Frequency of System Use

Table 8 shows the frequency of use of the transit system by sex for the two surveys. A larger percentage of women than men say they never use the transit system in both surveys, and about 6 percent more men than women use the system every day.

Respondents were asked to indicate the purpose of the trips for which they most frequently used the transit system. The most frequent trip purpose is summarized by sex in Table 9. Half of the women and 70 percent of the men most frequently use the transit system for trips to and from work. Table 10 shows most frequent trip purpose as a function of frequency of transit system use. Almost all of the frequent users use the transit system mostly for work trips. Only about one-fourth of the infrequent users say their most frequent trips are related to work; shopping, social, and other types of trips are likely to be identified in this way by infrequent users of the system.

The times of day during which the system is used are summarized in Tables 11 and 12 by sex and frequency of system use respectively. There is no differential pattern of use by sex. Both men and woman use the system mostly in the time periods from 6 to 9 a.m. and 4 to 7 p.m., which correspond to the trips to and from work. Slightly fewer women than men use the system during these peak periods and during the night hours. System use is very limited in the period from 7 p.m. to 6 a.m. However, the temporal pattern of system use does vary systematically with use frequency as shown in Table 12. A greater proportion of infrequent users are likely to use the system between 9 a.m. and 4 p.m. than of frequent users and they are less likely to use it during the morning and evening rush hours.

TABLE 8

FREQUENCY OF USE OF TRANSIT SYSTEM
(PERCENT)

Frequency	Survey 1 Male	Survey 1 Female	Survey 2 Male	Survey 2 Female
Never	8.5	19.3	9.7	17.1
A few times a year	25.0	28.4	25.0	23.0
A few times a month	13.6	9.6	11.8	11.2
A few times a week	9.7	5.7	10.5	12.4
Daily	43.2	37.0	42.9	36.2
N	352	384	380	356

TABLE 9

PURPOSE OF MOST FREQUENT TRIPS
USING THE TRANSIT SYSTEM
(PERCENT)

Trip Purpose	SURVEY 1 Men	SURVEY 1 Women	SURVEY 2 Men	SURVEY 2 Women
Work	71	56	70	54
School	3	2	3	5
Shopping	8	18	10	29
Social	8	14	6	7
Other	10	10	11	5

TABLE 10

PURPOSE OF TRIPS BY FREQUENCY OF SYSTEM USE FOR RESPONDENTS IN BOTH SURVEYS

Most Frequent Trip Purpose	Survey 1 Frequent Users	Survey 1 Infrequent Users	Survey 2 Frequent Users	Survey 2 Infrequent Users
Work	93%	27%	87%	26%
School	4%	1%	4%	2%
Shopping	1%	27%	7%	38%
Social	1%	23%	1%	15%
Other	.1%	21%	2%	19%

TABLE 11

PERCENT OF RESPONDENTS OF EACH SEX IN EACH SAMPLE WHO USUALLY USE THE SYSTEM AT PARTICULAR TIMES OF DAY

Time	Survey 1 Male	Survey 1 Female	Survey 2 Male	Survey 2 Female
Midnight - 6 a.m.	7	1	5	1
6 a.m. - 9 a.m.	58	52	62	54
9 a.m. - noon	21	23	20	23
Noon - 4 p.m.	26	20	22	27
4 p.m. - 7 p.m.	51	46	56	46
7 p.m. - Midnight	11	5	11	8
	351	389	387	363

TABLE 12

TIMES OF REGULAR SYSTEM USE BY SURVEY AND FREQUENCY

Times of Regular System Use	Survey 1 Frequent Users	Survey 1 Infrequent Users	Survey 2 Frequent Users	Survey 2 Infrequent Users
6 a.m. - 9 a.m.	84%	38%	81%	49%
9 a.m. - noon	10%	46%	16%	38%
Noon - 4 p.m.	16%	38%	18%	41%
5 p.m. - 7 p.m.	74%	35%	74%	38%
7 p.m. - midnight	10%	8%	10%	12%
Midnight - 6 a.m.	5%	4%	5%	2%

TABLE 13

QUESTION: DID YOU CONSIDER SAFETY AND SECURITY IN DECIDING WHETHER TO USE THE TRANSIT SYSTEM

Response	Survey 1 Male	Survey 1 Female	Survey 2 Male	Survey 2 Female
Yes, it was a major factor	33%	51%	36%	50%
Yes, one of several important factors	35%	36%	38%	37%
No, I did not consider it	26%	11%	21%	9%
I don't know	7%	2%	5%	4%
N	319	354	358	322

4.3 The Role of Personal Security in System Use

The primary focus of these surveys was perceived safety and security. To what extent do users of the transit system adjust their system use for reasons of safety? When asked whether they considered safety and security in deciding whether to use the system, half of the women and a third of the men said safety was a major factor; another 35-38 percent of each said it was one of several major factors (see Table 13). In both surveys, substantially more men than women said they did not consider security in deciding whether to use the transit system. As shown in Table 14, frequency of system use is even more strongly related to consideration of safety and security than sex is. Safety and security is a major factor in their decision not to use the transit system for most of the nonusers. Almost all nonusers report considering safety and security. Frequent users are more likely to report not considering this factor and are less likely to consider it a major factor in their mode choice decision.

When the respondents were asked whether there were times of day during which they were reluctant to use the transit system for reasons of safety and security, the results shown in Table 15 were found. Most users of both genders are reluctant to use the system at certain times. Both men and women are reluctant to use the system at night (7:00 p.m. to 6:00 a.m.). Relatively more women than men are reluctant to use the system at all times (see Table 16).

Thus, personal security is clearly implicated in the decision whether to use the transit system at all and for users it helps determine

TABLE 14

RATED IMPORTANCE OF SAFETY AND SECURITY AS A FUNCTION OF FREQUENCY OF TRANSIT SYSTEM USE

SURVEY 1

	Frequent User	Infrequent User	Nonuser
Major factor	33%	47%	60%
One of several factors	40%	34%	26%
Not considered	23%	15%	9%
Do not know	5%	4%	4%

SURVEY 2

	Frequent User	Infrequent User	Nonuser
Major factor	39%	42%	56%
One of several factors	38%	38%	34%
Not considered	19%	14%	7%
Do not know	4%	6%	3%

TABLE 15

ARE THERE TIMES WHEN YOU ARE RELUCTANT TO USE THE TRANSIT SYSTEM BECAUSE OF CONCERN FOR SAFETY AND SECURITY

	Survey 1		Survey 2	
	Male	Female	Male	Female
YES	80%	92%	81%	90%
NO	16%	3%	13%	4%

TABLE 16

PERCENTAGE OF RESPONDENTS OF EACH SEX WHO EXPRESSED RELUCTANCE TO USE THE TRANSIT SYSTEM AT CERTAIN TIMES

	Survey 1		Survey 2	
Time	Male	Female	Male	Female
Midnight - 6 a.m.	75.5	85	54	63
6 a.m. - 9 a.m.	10	19	6.5	13
9 a.m. - noon	14	18	13	24
Noon - 4 p.m.	17	22	15.5	27.5
4 p.m. - 7 p.m.	4	9	5	13
7 p.m. - midnight	71.5	83	70	80

the times of system use. Perceived security seems to have a greater influence on women than on men.

4.4 Ratings on System Attributes

Respondents rated ten attributes of the transit system. These included the standard factors usually discussed in models of mode choice (cost, convenience, frequency of service, reliability and comfort) in addition to factors relating to perceived safety and security (personal security, frequency of police patrols, accident safety, condition of vehicles and of stations). Each attribute was rated using a six-point scale varying from very good = 1 to very bad = 6; thus, a mean rating of 3.5 represents the neutral point. Mean ratings for selected factors are shown by sex and frequency of use in Table 17 for the two waves of the survey. Over all attributes, the ratings are surprisingly similar for men and women - the same pattern of ratings is evident for the two sexes in both surveys. On the attributes personal security, frequency of police patrol, and accident safety, women rated the system worse than the men did. However, the overall ratings on accident safety are quite favorable, while those for the other two attributes are unfavorable. The critical finding for this context is that in both surveys, women rate the transit system less favorably in terms of personal security than men do.

In the first survey, there are clear and pronounced differences between frequent users, infrequent users, and nonusers in how good they rated the transit system on personal security. In the second survey,

TABLE 17

MEANS AND STANDARD ERRORS FOR RATINGS
OF SELECTED FACTORS BY SEX AND FREQUENCY
OF SYSTEM USE

	Men	Women	Frequent Users	Infrequent Users	Nonusers
SURVEY 1					
Personal Security	4.18	4.44	4.01	4.40	4.98
	(.07)	(.06)	(.06)	(.07)	(.12)
Accident Safety	2.58	2.92	2.71	2.75	2.99
	(.06)	(.07)	(.06)	(.07)	(.15)
Frequency of Police Patrol	4.13	4.31	4.20	4.15	4.41
	(.06)	(.06)	(.06)	(.07)	(.13)
Sample Size	341	373	351	279	102
SURVEY 2					
Personal Security	4.22	4.58	4.30	4.29	4.99
	(.07)	(.07)	(.07)	(.08)	(.13)
Accident Safety	2.65	3.18	2.98	2.74	3.11
	(.06)	(.07)	(.07)	(.07)	(.15)
Frequency of Policy Patrol	3.99	4.33	4.24	4.03	4.13
	(.06)	(.07)	(.07)	(.08)	(.14)
Sample Size	378	342	375	261	90

frequent and infrequent users do not differ in how they rate personal security but both differ from nonusers.

A separate survey item asked respondents how secure or unsecure they felt the transit system was. Table 18 shows the results; higher numbers indicate less security. The same pattern noted above in the attribute ratings is evident here. Distributions for the data on this item from the first survey are shown in Figure 9. The concentration of responses in the most negative category ("very insecure") is quite surprising. Even for frequent users, over 10 percent of them feel the transit system is dangerous; while over 50 percent of the nonusers think so.

4.5 Security Ratings by Time and Place

Respondents rated how secure they felt at different times and places in the transit system. Their ratings were done using 6 scale points with 1 meaning "very secure" and 6 meaning "very insecure." Figure 10 illustrates the task, the distinctions involved, and the main results. These results are based on data from the first survey. Perceived security was rated as a function of time of day (day, evening, night), location (inside or around a terminal), and terminal (local vs. a remote, but well-known central business district, station). Several findings are apparent in Figure 10: (1) the local terminal is regarded as safer at any given time than the remote terminal; (2) the area around the home station is perceived as more secure than inside the home station for the same times; and (3) there is a strong time of day effect - night is less secure than evening, which is less secure than day, regardless of location or terminal.

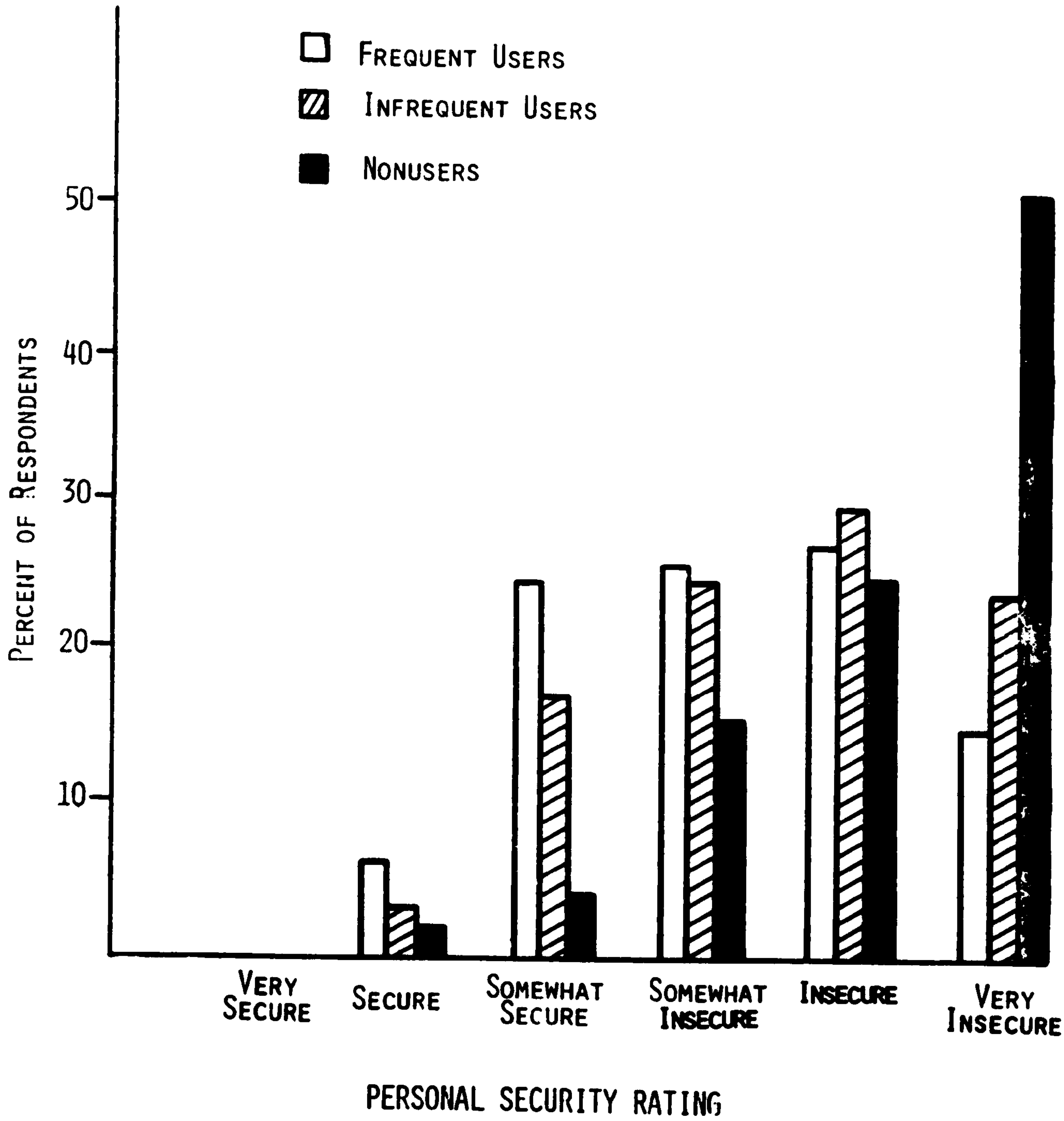


Figure 9. Distributions of Rated Security by Frequency of System Use, Data From First Survey.

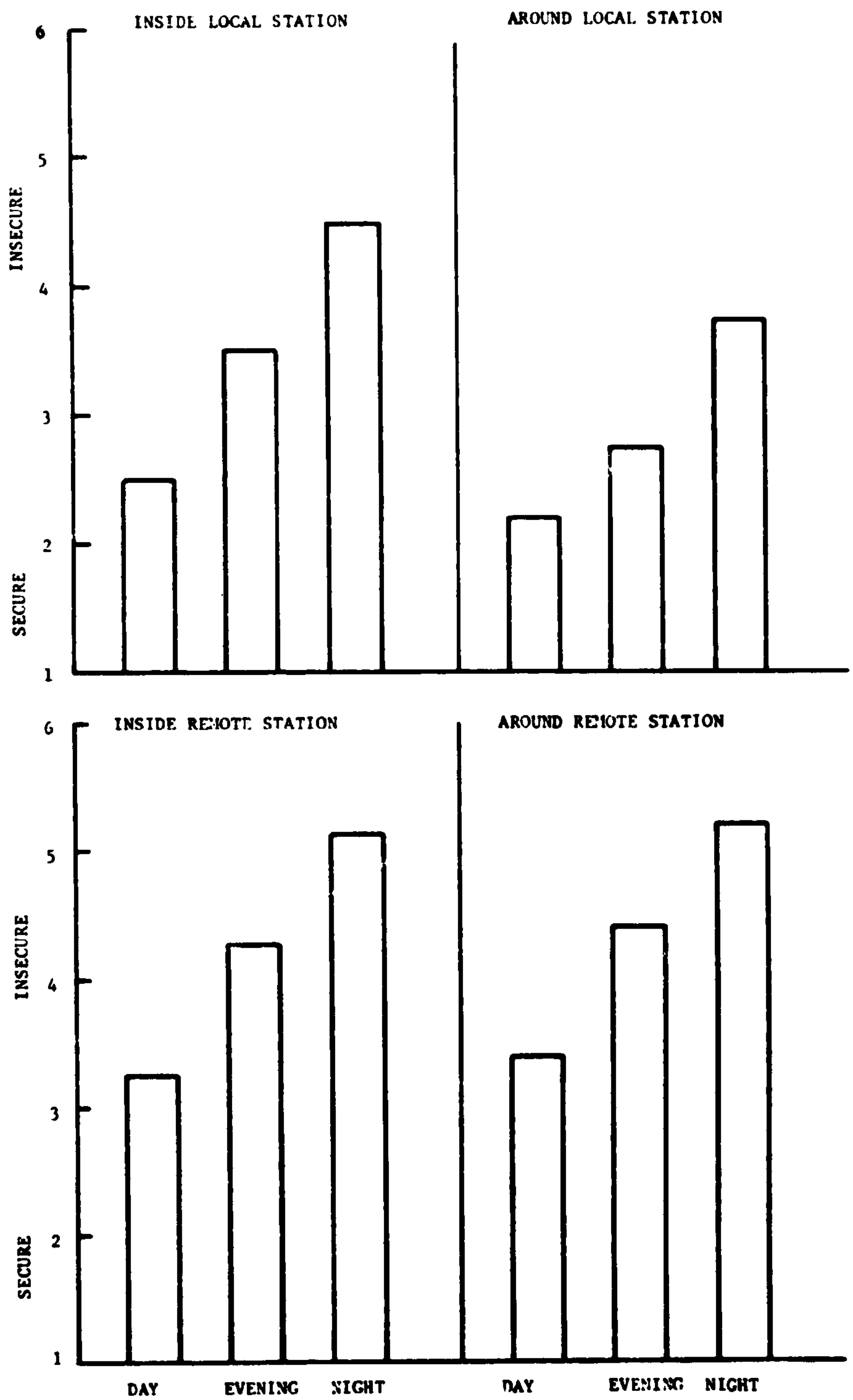


Figure 10. Rated Security by Location and Time, First Survey

TABLE 18

MEAN PERSONAL SECURITY RATINGS
BY SURVEY AND FREQUENCY
OF SYSTEM USE*

	Survey 1	Survey 2
Frequent users	4.21 (.06)	4.44 (.06)
Infrequent users	4.56 (.07)	4.39 (.07)
Nonusers	5.21 (.12)	5.15 (.11)

* Entries in parentheses are the standard errors corresponding to each mean. The perceived security scale ranges from 1 (very secure) to 6 (very insecure).

Figures 11 and 12 show similar data, partitioned by frequency of system use for surveys 1 and 2, respectively. In the first survey there is a clear separation of the ratings by the three user categories with the order of ratings as one would expect. In the second survey, frequent and infrequent users give similar ratings, but both differ from nonusers. Nonusers regard the transit system as unsafe at both their home terminal and a selected remote terminal and at all times of the day.

The data presented above were aggregated over all home stations. A user's home station is the terminal through which she/he usually enters the transit system. The next four figures partition the data by home station and sex of the respondent. In Figure 13 rated security at the local terminal is shown for those respondents who identified the <u>experimental</u> site as their home station. It was hypothesized that these respondents should feel safer after the experimental changes in their home station than thev did prior to such changes. Such enhanced safety should be specific to the home station and should be limited to inside the station. There are at least no reasons to expect it to be generalized to other stations. The hypothesized reults were wrong in several respects: (1) men rated the local terminal less safe after the change than before; they also rated the area around the local terminal as less safe in the post-test survey - this difference occurred at all times of day; (2) women rated the local terminal as more secure in the evening and at night following the station alternations, but there was no difference in their ratings concerning the day. A similar pattern of ratings was obtained for the neighborhood around the home station. Thus, men

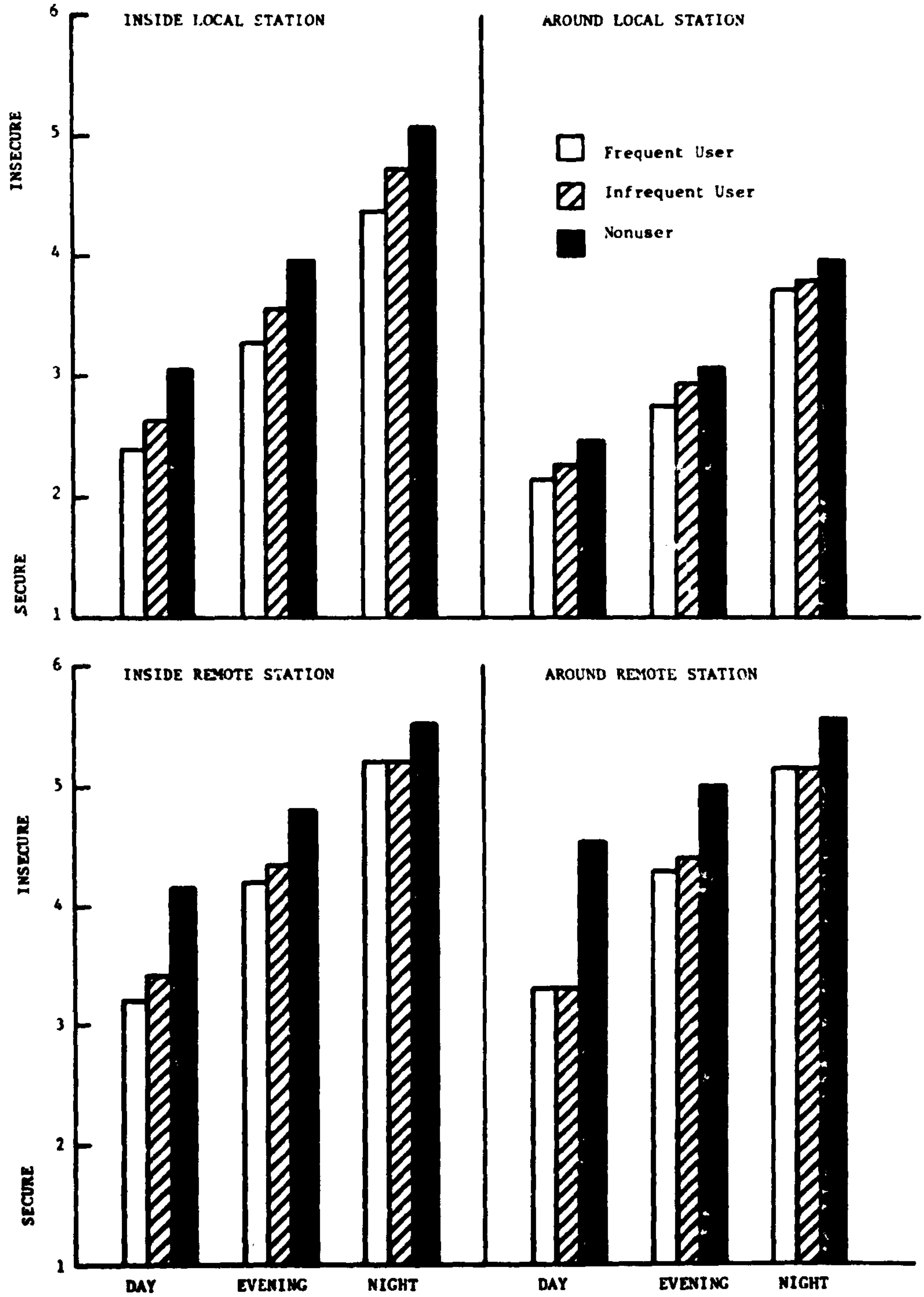


Figure 11. Rated Security by Time, Place, and Frequency of System Use; First Survey

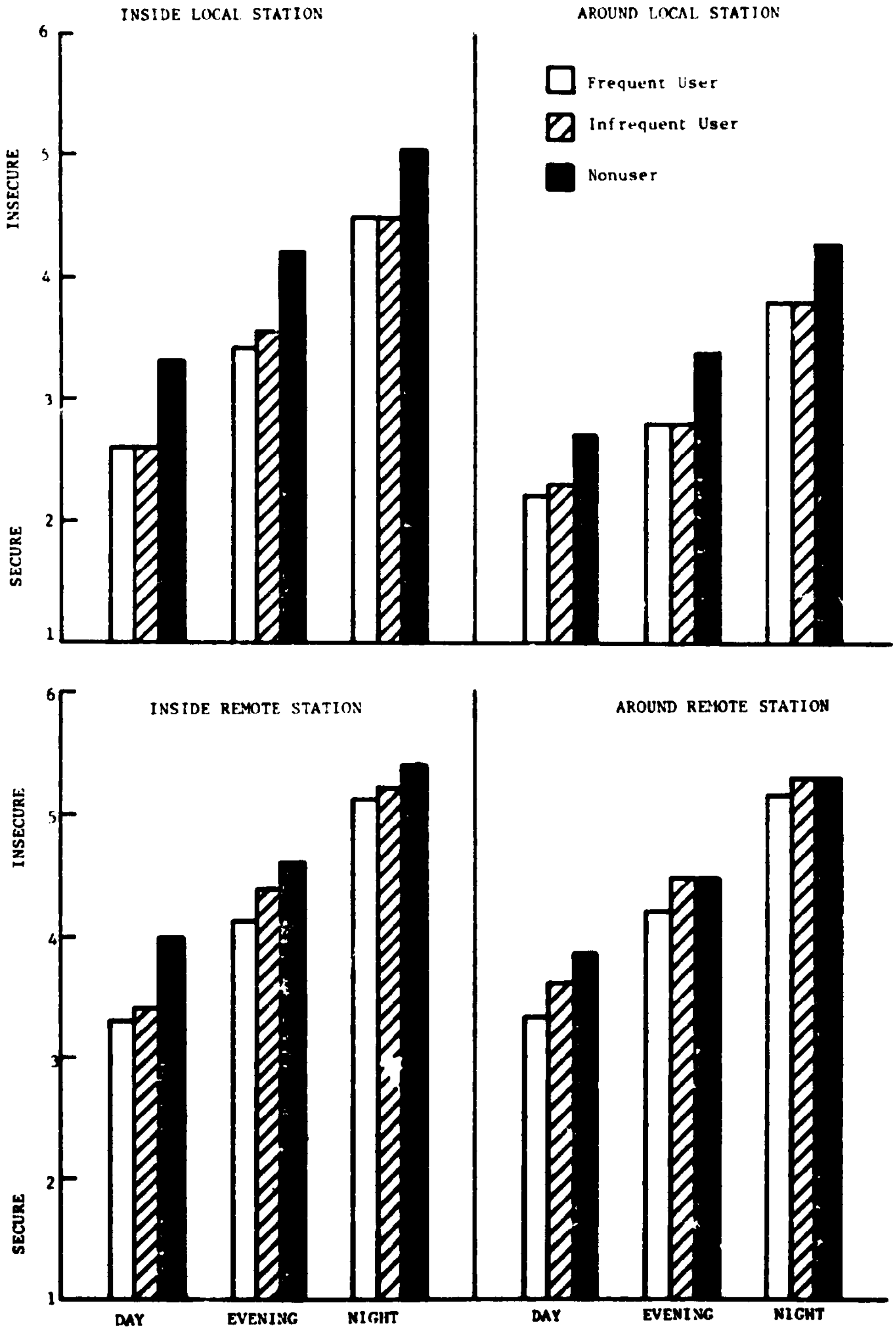


Figure 12. Rated Security by Time, Place, and Frequency of System Use; Second Survey

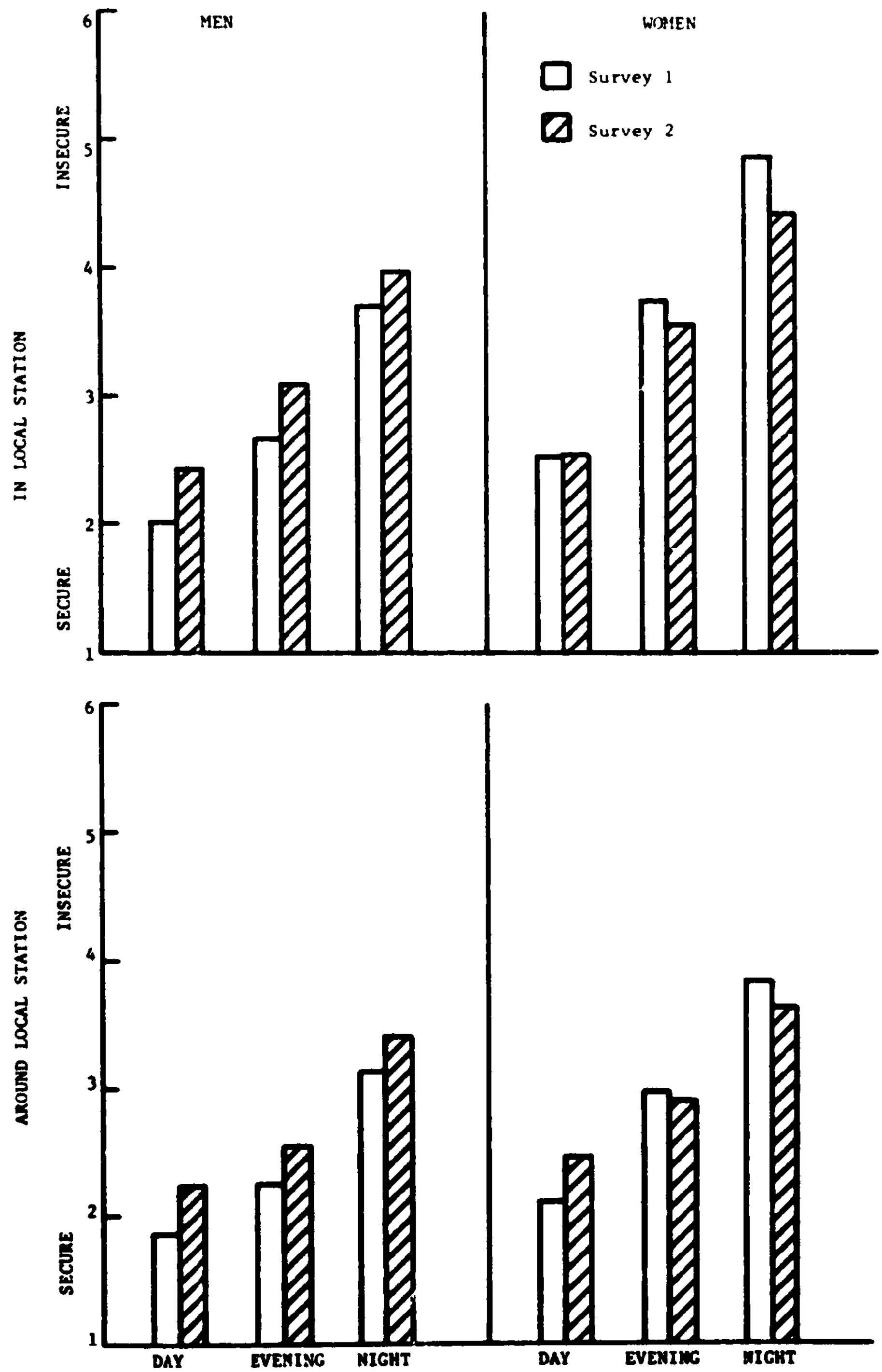


Figure 13. Rated Security of Local Terminal by Experimental Site Respondents

seem to feel less safe in and around their home station after the experimental modification of the terminal, while women feel more secure in and around the station in the evening and night.

When these same respondents rate a remote terminal, the results in Figure 14 were obtained. Men tended to rate the remote terminal as somewhat less secure at the time of the second survey than in the first survey; and the surrounding area was seen as slightly less secure. For women, there were no differences in their ratings of either the remote terminal or its neighborhood between the two surveys.

Data from respondents who identified the CONTROL site as their home station are shown in Figure 15 and 16. Here men rated both their local terminal and the remote terminal no differently in the two surveys. The only discrepancy is a slight tendency for men to rate the area around the remote terminal as less safe in the day. Women, however, tend to rate both stations as slightly less safe in the second survey than in the first.

Thus, the effects of experimental changes in the target station were to enhance perceived security for women at certain times, but to decrease perceived security for men at all times. Perhaps women felt more secure because transit police were trying to improve security, while men felt less secure for the same reason. The men might be thinking, "If these security gadgets are necessary, things must be worse than I thought." Recall that in general men do feel more secure initially than women do while using the transit system. When the data were

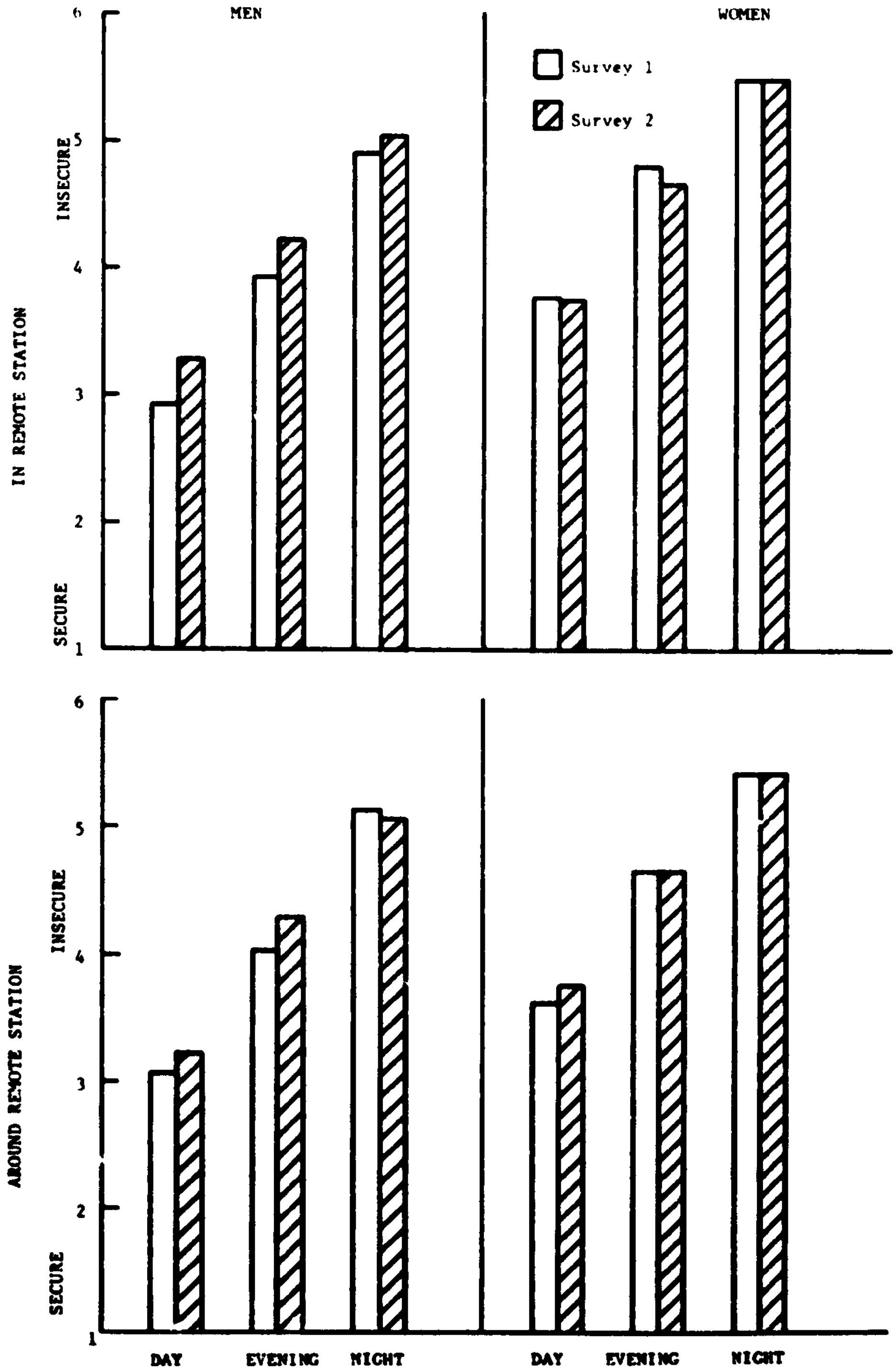


Figure 14. Rated Security of the Remote Terminal by Experimental Site Respondents

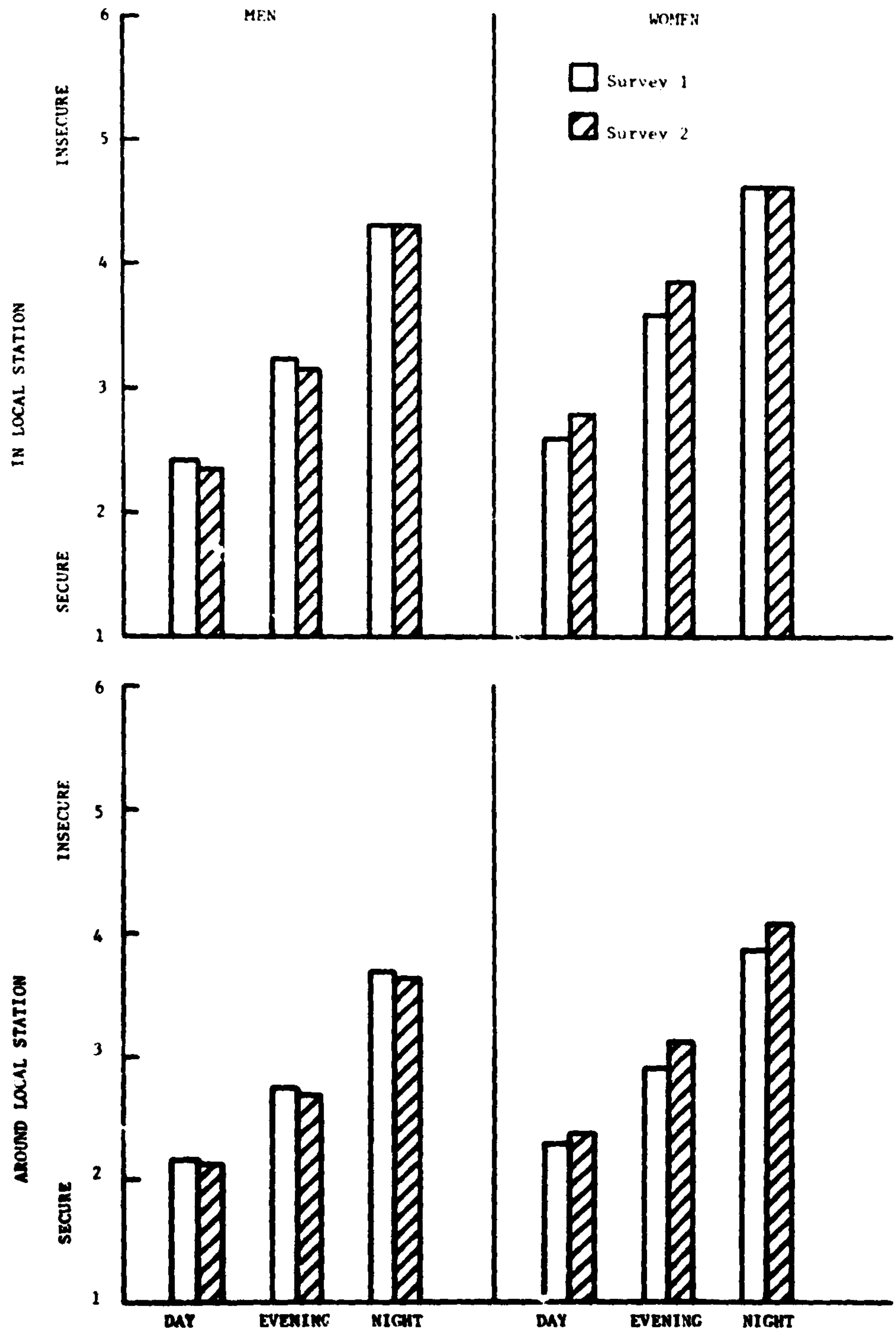


Figure 15. Rated Security of Local Terminal by Control Site Respondents

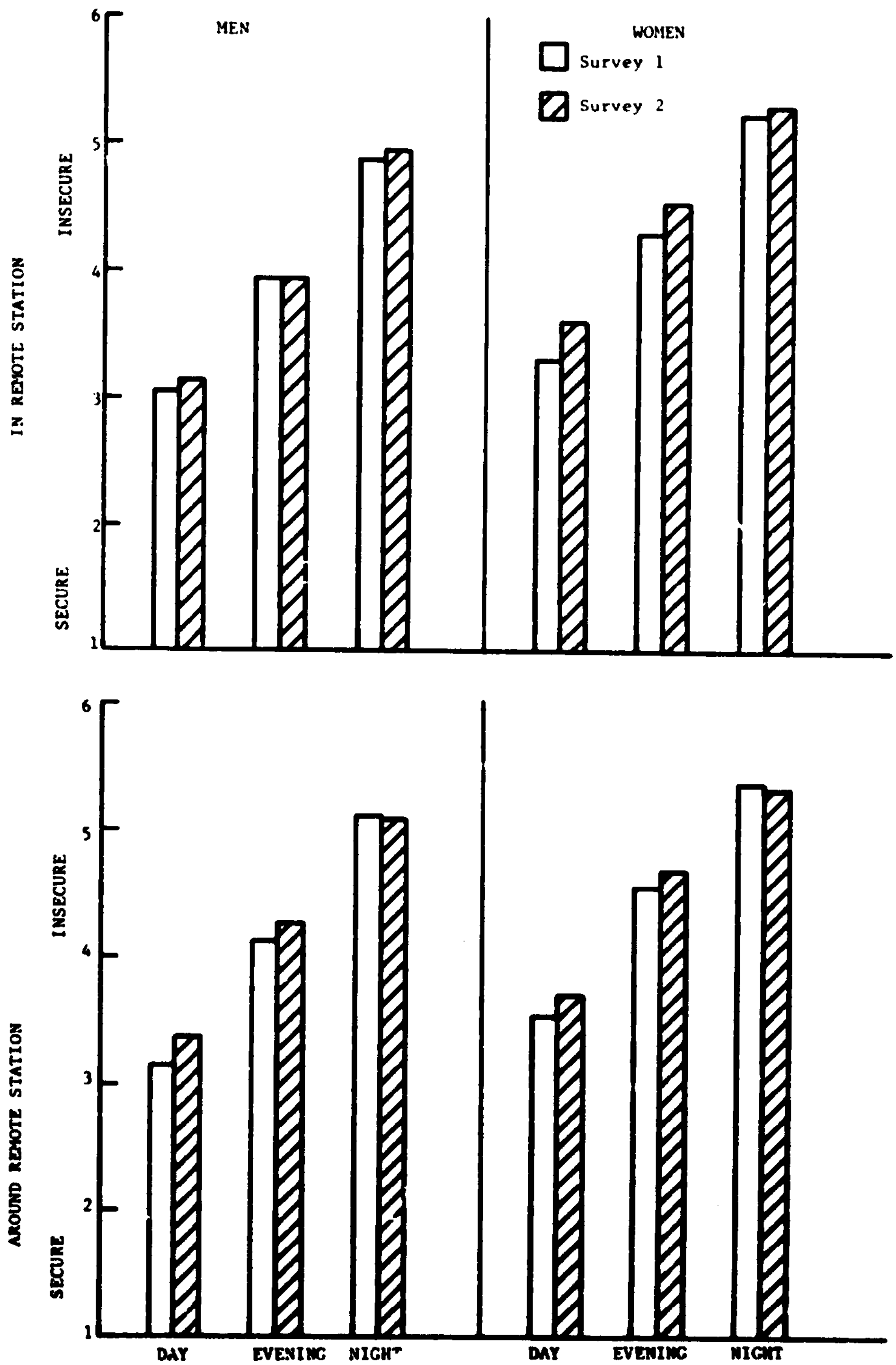


Figure 16. Rated Security of the Remote Terminal by Control Site Respondents

separated for frequent and infrequent users, the trends reported above hold for both data sets.

4.6 Perceived Changes in Crime Levels

Respondents were asked whether they had perceived any change in the level of crime at their local station over the prior six months. The distribution of responses by gender is shown for the two surveys in Table 19 for respondents from the two target stations. In the second survey, about 25% of the female respondents said crime had decreased at the experimental site; while only 5 percent of them said it had increased. This pattern is quite different from that for men or for either gender at the control site. The percentage of respondents at the control site saying that crime decreased is about equal to the percentage saying it increased - for both sexes. For men at the experimental site, 16 percent said crime decreased, 11 percent said it increased. Thus, the clearest effect of the crime countermeasure was on women - more of them believed that crime had decreased at the experimental site after the installation of the CCTV.

Respondents indicated what sources of information they thought influenced their beliefs about the level of crime at their local station - similar results were evident for men and women (see Table 20). Personal observation and discussions with friends and relatives are said to be the primary sources. Media coverage is cited by fewer respondents, but it is a potent source of information.

4.7 Personal Experience with Crime

When asked about their personal experiences with crime, few respondents had actually been victims, but a larger proportion said that

TABLE 19

CHANGE IN CRIME LEVEL AT LOCAL TRANSIT STATION, PARTITIONED BY HOME STATION

	Survey 1		Survey 2	
	Men	Women	Men	Women
Experimental Site				
Decreased	10%	3%	16%	24%
Remained the same	79%	87%	73%	71%
Increased	11%	10%	11%	5%
Control Site				
Decreased	5%	7%	12%	16%
Remained the same	88%	82%	76%	70%
Increased	7%	11%	12%	14%

TABLE 20

BASES FOR BELIEFS CONCERNING CRIME LEVEL
AT LOCAL TRANSIT STATION*

Source of Information	Survey 1		Survey 2	
	Men	Women	Men	Women
Personal observation	91%	85%	91%	87%
Media coverage	66%	65%	55%	62%
Discussions with friends, etc.	82%	91%	83%	83%
Other sources	24%	24%	20%	17%

* Entries are percent of respondents to each item indicating that each source influenced their beliefs.

they had witnessed crimes, and most people reported having friends who had been victims (see Table 21 and 22). The crimes most frequently witnessed were against personal property; such crimes were more frequent than all other crimes combined. There were no differences by sex in the types of crimes observed. The final question in this series asked respondents whether they feared being victims of crime while using the transit system: about 90 percent of the women respondents and 80 percent of the men did.

Table 22 shows consistency between the two survey waves in the experience of frequent and infrequent users. There is some ambiguity in the responses on nonusers to this item. More of the frequent users of the transit system have been victims and witnesses of crimes than the infrequent users. Furthermore, frequent users slightly more often have friends who have been victims of transit crime. Yet they generally rate the system as safer than infrequent users do, and the group that rates the system as least safe has had the least direct experience with crime on it. All this, of course, is a matter of exposure time - frequent users see more crime because they are in the system more and have more chance to see it. But the important point is that perceived safety is not a direct function of personal experience with crime. There is a large discrepancy between the number of people who have seen crimes and those who fear crimes - this difference reflects the importance of indirect sources of information in shaping peoples' perceived security.

4.8 Why Nonusers Say They Do Not Use the System

A free response survey item was included to allow nonusers to give their reasons for not using the transit system. A variety of reasons

TABLE 21

EXPERIENCE WITH CRIME

	Survey 1		Survey 2	
	Men	Women	Men	Women
Crime victim	14%	12%	14%	16%
Crime witness	29%	26%	29%	30%
Friend who was victim	70%	72%	70%	77%
Fear being victim	79%	88%	79%	91%

TABLE 22

CRIME EXPERIENCE BY FREQUENCY OF SYSTEM USE

SURVEY 1	Frequent Users	Infrequent Users	Nonusers
Crime victim	16%	10%	3%
Crime witness	40%	17%	6%
Friend who was a victim	71%	64%	55%
Fear being a victim	79%	82%	61%
SURVEY 2			
Crime victim	19%	9%	4%
Crime witness	42%	19%	0%
Friend who was a victim	70%	63%	46%
Fear being a victim	82%	74%	62%

emerged, but a few dominant ones were apparent. The most frequently cited reason for both men and women in both surveys was that they felt the transit system was insecure. The second most frequent single reason was that another mode was preferred. This other mode was always a car. Other reasons fell into two categories--one dealing with sensory aggravation, the other with system service factors. Responses such as noisy, dirty and uncomfortable were quite frequent. Table 23 shows the percent of respondents of each sex and survey who cited each of the four kinds of reasons for avoiding the transit system.

TABLE 23

REASONS GIVEN BY NONUSERS
FOR NOT USING THE TRANSIT SYSTEM*

	Survey 1		Survey 2	
	Men	Women	Men	Women
Insecure	41%	64%	42%	53%
Prefer Other Mode	35%	23%	27.5%	21.5%
Sensory Input (Dirty, noisy, uncomfortable)	26.5%	24.3%	29%	25.8%
System feature (Cost, reliability, convenience)	36.7%	19.6%	21.7%	25.8%
N of respondents	49	107	69	93

* The percentages are based on the N given for each column. Some respondents gave more than one reason.

5. REFINING THE MODELS

Two types of models of perceived security were discussed in Section 2: a model of the role of perceived security in transit system use and a model of the determinants of perceived security. In this section, the data provided by the surveys will be incorporated into the models.

5.1 The Role of Perceived Security in Transit System Use

The importance of perceived security as a determinant of transit system use is clearly demonstrated by several results presented above: (1) ratings of perceived security are clearly influenced by the frequency of system use, (2) the most frequent reason given by nonusers for not using the transit system is that it is unsafe, (3) most respondents indicate that there are times of the day when they are reluctant to use the transit system for reasons of security, and (4) the times most people express reluctance to use the system are in fact the times when they report not using the system.

Respondents rated the transit system in terms of how good or bad they thought it performed on a series of ten attributes. These were reliability, convenience, cost, comfort, frequency of service, accident safety, personal security, frequency of police patrol, condition of stations and condition of vehicles. Such ratings were obtained during both survey waves. As shown in Figure 8, respondents in both samples had been classified into three categories based on frequency of system use: frequent users; infrequent users, and nonusers. Discriminant analyses were done for each survey wave to determine which of the rated system attributes best differentiated the three categories of users.

Discriminant analysis is a statistical technique for determining linear combination(s) of a set of variables which best separate objects into predefined groups. In our case, the objects are people, the groups are frequent users of transit, infrequent users, and nonusers, and the predictor variables are the ten transit system attributes (cost, comfort, personal security, etc). Our goal is to find a model of the form shown in Section 2.1; that is, a linear model for predicting transit use. This technique will allow us to find the statistically best linear model for these data. Discriminant analysis is similar in several ways to multiple regression analysis, although it is less familiar to most researchers. Details of the technique may be found in Tatsuoka (1970, 1971).

The goal of a discriminant analysis is to find the best linear combination of a set of discriminating variables (input) to separate persons into groups. Such a linear combination is called a discriminant function. Sometimes there is more discriminating power in a set of variables than is captured by the first discriminant function. In that case, other such functions may be derived. The discriminant function coefficients are the weights associated with each of the variables in the linear combination. When these weights are derived for variables in standard score form (transformed so that their mean is zero and the standard deviation is one), they reflect the relative importance of each variable to the differentiation between groups. Those variables whose standardized discriminant function coefficients have the largest absolute value are the ones which make the greatest contribution to the discriminant function. In several ways, these coefficients are similar to those in standard multiple regression analysis.

The weights are derived by solving the classic eigenvalue problem of matrix algebra (see Tatsuoka, 1971). An eigenvalue is computed which corresponds to each of the discriminant functions. It provides a measure of the importance of each function, and tests of the size of the eigenvalues are used to determine how many discriminant functions are appropriate for a particular set of data. The sum of all the eigenvalues is equal to the total variance of the input variables. The percent of variance accounted for by the discriminant function is given by the ratio of its eigenvalue to the sum of all the eigenvalues.

Criteria for the importance of each of the discriminating variables to the discriminant function include Wilk's lambda and Rao's V. Wilk's lambda reflects how much discriminating power remains in the set of variables after each discriminant function is removed. Thus it measures residual discriminating capability. Rao's V is a measure of distance between groups - this criteria measures the degree to which each variable contributes to the overall separation between groups.

5.1.1 Discriminant Analysis for Data from the First Survey

Both direct and stepwise discriminant analyses were conducted. Two discriminant functions were statistically justified by both analyses, and the stepwise procedure eventually incorporated all ten predictor variables, thus finally resulting in the same solution as the direct analysis.

The first discriminant function accounted for 94 percent of the variance, while the second function accounted for only six percent. The standardized discriminant function coefficients for the ten system attributes are shown in Table 24. The dominant first function is almost totally dependent on personal security. None of the other variables is even half as important for differentiating the respondents into frequency-of-use categories. The second discriminant function is primarily influenced by comfort with some contribution from convenience.

Table 25 shows the centroids of the frequency of use groups in the reduced space defined by the two discriminant functions. A centroid is a mean location for a group specified on all dimensions - in this case 2, one for each discriminant function. The mean discriminant scores on the first function are ordered by frequency of use and clearly separate users from nonusers. Thus, this function is the interesting one for our model. The second function differentiates infrequent users from both frequent users and nonusers. Comfort and convenience are primarily implicated in this second function. These variables are apparently important to infrequent users but not to respondents in the other two groups. They are inconsequential for nonusers and satisfactory or unimportant for frequent users.

Table 26 shows the results of predicting how frequently a person will use the transit system using the results of the discriminant analysis. The use of the two functions successfully classified 48 percent of the cases. This classification table has a χ^2 of 66.125,

TABLE 24

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

	FUNCTION 1	FUNCTION 2
Reliability	-.39	-.23
Convenience	.02	.47
Personal Security	1.23	.06
Cost	.24	.19
Condition of Vehicles	-.03	.25
Frequency of Service	.08	.25
Comfort	-.31	-.69
Accident Safety	.17	-.31
Frequency of Police Patrols	-.36	-.28
Condition of Station	.04	-.29
Eigenvalue	.13	.01
Percent of variance	94	6

TABLE 25

CENTROIDS OF DISCRIMINANT SCORES
FOR FREQUENCY-OF-USE GROUPS;
SURVEY 1 DATA

	DISCRIMINANT SCORES	
	Function 1	Function 2
Nonusers	.749	-.131
Infrequent Users	.126	.114
Frequent Users	-.314	-.053

TABLE 26

CLASSIFICATION RESULTS FOR
FREQUENCY OF SYSTEM USE;
SURVEY 1 DATA

	Predicted Group Membership			
Actual Group	Nonuser	Infrequent User	Frequent User	N
Nonuser	61 (66%)	15 (16%)	17 (18%)	93
Infrequent user	87 (34%)	76 (29%)	95 (37%)	258
Frequent user	77 (24%)	60 (18%)	188 (58%)	325

which is highly significant ($\alpha \leq .000$). The chi-squared statistic (χ^2) reflects the degree of association in a contingency table; α is a measure of the statistical significance of the χ^2 value. The analysis predicted best in the nonuser and frequent user groups, achieving better than 50 percent correct classification in both groups. But 70 percent of the infrequent users were misclassified based on their discriminant scores.

A summary table of the step-wise discriminant analysis is presented as Table 27. This analysis was performed using Wilk's lambda as the criterion for variable inclusion. By that criterion all ten variables made significant contributions to discriminating the three groups. Rao's V, another possible criterion, was also computed. It confirms the overwhelming importance of personal security as a determinant of frequency of transit system use. Comfort is the other dominant variable.

Thus, our model of the role of perceived system attributes in determining frequency of transit system use involves two discriminant functions--one influenced by perceived security, the other by comfort and convenience. Our model of the role of perceived security is given by the first discriminant function.

5.1.2 Discriminant Analysis for Data from the Second Survey

The second wave of survey data was collected after the installation of security equipment at the experimental site. This was accompanied by publicity and media coverage. The presence of new security equipment and the media coverage were expected to enhance feelings of personal security among possible users of the transit system and to lessen the

TABLE 27

SUMMARY FOR STEPWISE DISCRIMINANT ANALYSIS PREDICTING FREQUENCY OF SYSTEM USE FROM PERCEIVED SYSTEM ATTRIBUTES

Variable	F to Enter or Remove	WILKS Lambda	Rao's V	Significance of Change in Rao's V
Personal security	31.21	.915	62.43	.000
Comfort	6.10	.899	75.42	.000
Frequency of police patrol	2.29	.893	80.47	.080
Cost	1.98	.887	84.85	.112
Reliability	2.36	.881	90.18	.07[illegible]
Accident safety	.86	.879	92.11	.380
Convenience	.55	.878	93.25	.567
Frequency of service	.25	.877	93.78	.765
Condition of stations	.09	.877	93.98	.907
Condition of vehicles	.10	.876	94.20	.897

TABLE 28

STANDARDIZED DISCRIMINANT FUNCTION
COEFFICIENTS FOR DATA FROM THE
SECOND SURVEY

	FUNCTION 1	FUNCTION 2
Reliability	-.68	-.35
Convenience	.47	-.07
Personal security	.87	-.41
Cost	-.12	-.04
Condition of vehicles	-.21	.45
Frequency of service	.08	-.20
Comfort	-.14	-.71
Accident safety	-.16	-.07
Frequency of police patrols	-.63	.39
Condition of stations	.38	.08
Eigenvalue	.08	.04
Percent of variance	69	31

apparent impact of security on frequency of system use. To test these hypotheses, a set of discriminant analyses were performed on the data from the second survey.

The analyses produced two discriminant functions. As before, the stepwise solution incorporated all ten predictor variables based on the criterion of Wilk's lambda. The resulting standardized discriminant function coefficients appear in Table 28. The eigenvalues and percent of trace values are also shown for both functions. The first function accounts for most of the variance, but the second function is also quite important with this data. The first function is primarily influenced by personal security, frequency of police patrols, and reliability. Comfort has the greatest influence on the second discriminative function. Thus, comparing Table 28 with Table 24, it is evident that the discriminative power of perceived security is less at the time of the second survey.

Table 29 shows the same general pattern of centroids for the three groups based on frequency of use. As before, the first discriminant function orders the groups by frequency of transit system use. The classification results are shown in Table 30. Overall the discriminant functions achieve 47 percent correct classifications. However, at the time of the second survey, the pattern of correct classifications changes somewhat: the percent of correct classifications increases for infrequent users and decreases for nonusers and frequent users. The extreme categories are predicted less well when the importance of perceived security is diminished.

TABLE 29

CENTROIDS OF DISCRIMINANT SCORES
FOR FREQUENCY-OF-USE GROUPS: SURVEY 2 DATA

	Discriminant Scores	
	Function 1	Function 2
Nonusers	.547	-.352
Infrequent users	.185	.234
Frequent users	-.253	-.070

TABLE 30

CLASSIFICATION RESULTS FOR
FREQUENCY OF SYSTEM USE:
SURVEY 2 DATA

	Predicted Group Membership			
Actual Group	Nonusers	Infrequent Users	Frequent Users	N
Nonusers	45 (52%)	21 (24%)	21 (24%)	87
Infrequent users	70 (29%)	101 (42%)	68 (29%)	239
Frequent users	84 (23%)	102 (28%)	176 (49%)	362

TABLE 31

SUMMARY FOR STEPWISE DISCRIMINANT ANALYSIS PREDICTING FREQUENCY OF SYSTEM USE FROM PERCEIVED SYSTEM ATTRIBUTES

Variable	F to Remove or Enter	Wilks Lambda	Rao's V	Significance of Change in Rao's V
Reliability	10.77	.969	21.55	.000
Personal security	9.73	.943	41.12	.000
Frequency of police patrols	7.55	.922	56.75	.000
Convenience	4.80	.909	66.95	.006
Comfort	2.96	.902	73.07	.047
Condition of stations	1.93	.897	77.22	.126
Condition of vehicles	1.67	.892	80.75	.171
Accident safety	.53	.891	81.90	.563
Frequency of service	.29	.890	82.52	.736
Cost	.29	.889	83.16	.725

The summary statistics from the step-wise discriminant analysis, shown in Table 31, reveal that at least five discriminant variables are important for differentiating the three groups. Reliability and convenience have become more important than they were at the time of the first survey. Personal security and comfort remain quite important, but their role is relatively less than in the first survey. Thus, expectations based on our theory of the role of perceived security were borne out by these data and analyses.

5.1.3 Discriminant Analyses by Sex of Respondent

In an earlier section, the different responses of men and women to the security changes were reported. Men reported feeling generally less safe after the experimental changes at the target station, while women reported feeling safer in the evening and at night. Since sex of the respondent influenced specific ratings of personal security as a function of time and place, it is necessary to use sex as a moderator variable for our discriminant analyses.

Separate discriminant analyses were performed for men and women for the data from each survey. The standardized discriminant function coefficients are presented in Table 32. There are some differences in the coefficients for men and women in the first survey, but the importance of personal security is similar for both sexes. The first discriminant function is primarily influenced by personal security, and it accounts for about 4/5 of the trace of both men and women. The first function scores order the group centroids to correspond to frequency of system use (see Table 33) for both sexes.

At the time of the second survey, personal security is less salient for female respondents. Its coefficient drops to half that found in the first survey. Other factors become more important for women in discriminating the three user categories. The first discriminant function is still influenced by personal security, but less so for women. The group centroids in Table 33 are still appropriately ordered for data from the second survey.

Univariate F ratios were computed separating the three user groups on each system attribute. This amounts to computing a one-way analysis of variance for each discriminating variable. The F-ratio tests the equality of the means of the three groups on each variable. The results are shown in Table 34. Clearly, the importance of personal security declines for both men and women in the second survey. Other variables are more important discriminators for women, especially comfort, reliability and frequency of service. Thus, after improving the perceived security of the transit system, other variables emerge as important determinants of system use for women.

The model of the role of perceived security in transit system use, as shown in Table 32, depends on the sex of the respondent and changes differentially by sex as a result of experimental changes in security procedures.

TABLE 32
STANDARDIZED DISCRIMINANT FUNCTION
COEFFICIENTS FOR DATA FROM EACH SEX IN BOTH SURVEYS

	Survey 1		Survey 2	
	Fn1	Fn2	Fn1	Fn2
Men				
Reliability	-.81	-.48	-.45	-1.07
Convenience	.05	-.06	.19	.35
Personal security	1.23	-.05	1.02	-.18
Cost	.11	-.39	-.10	-.26
Condition of vehicles	.17	-.57	-.48	.61
Frequency of service	.35	.76	-.27	.54
Comfort	-.16	.81	.60	-.28
Safety from accidents	.10	-.16	.04	-.22
Frequency of police patrol	-.40	.33	-.70	-.09
Condition of stations	.02	-.27	.20	.14
Eigenvalue	.12	.03	.07	.03
Percent of trace	77	23	72	28
Women				
Reliability	.06	-.70	-.61	-.33
Convenience	.04	.36	.35	.39
Personal security	1.20	.25	.59	.60
Cost	.25	-.08	-.05	-.06
Condition of vehicles	-.18	-.42	-.14	-.25
Frequency of service	-.19	.93	-.03	.50
Comfort	-.32	-.10	-.61	.60
Safety from accidents	.06	-.43	-.08	-.11
Frequency of police patrol	-.32	.06	-.34	-.58
Condition of stations	.04	-.24	.33	.10
Eigenvalue	.17	.04	.15	.07
Percent of trace	80	20	68	32

TABLE 33

CENTROIDS OF GROUPS IN REDUCED SPACE

	Survey 1		Survey 2	
	Fn 1	Fn 2	Fn 1	Fn 2
Men				
Nonusers	.990	.343	.822	-.229
Infrequent users	.143	-.218	.066	.226
Frequent users	-.246	.108	-.174	-.114
Women				
Nonusers	.740	-.220	.408	.593
Infrequent users	.085	.255	.403	-.256
Frequent users	-.381	-.129	-.375	.001

TABLE 34

UNIVARIATE F-RATIOS ASSOCIATED WITH EACH
VARIABLE ENTERING THE DISCRIMINANT ANALYSES FOR
EACH SEX AND SURVEY

	MEN		WOMEN	
Variable	Survey 1	Survey 2	Survey 1	Survey 2
Reliability	.05	2.70	1.29	9.05**
Convenience	.42	.32	.78	3.56*
Personal security	10.72**	3.81*	19.00**	3.06*
Cost	1.40	1.08	1.86	1.65
Condition of vehicles	1.53	.08	1.96	3.83*
Frequency of service	1.71	.54	.29	8.33*
Comfort	1.04	.94	.98	13.79**
Accident safety	.60	.80	1.84	3.41*
Frequency of police patrols	1.17	1.15	.79	2.32
Condition of stations	1.21	.32	1.99	1.11

** $\alpha \leq .01$

* $\alpha \leq .05$

5.2 Factors Influencing Perceived Security

In the model described in Section 2.2, sets of factors influencing perceived security were postulated. Data on the effects of some of those factors were discussed in Section 4 of this report. The present section will review some of those findings in relation to the model of perceived security. In particular, we wish to establish whether (1) the variables in the model are in fact important, (2) the coding or quantification proposed for the variables is reasonable in light of relevant data, and (3) the particular combination rules for forming components still seem reasonable. Not all of the variables in the model were included in this study. Therefore,not all aspects of the model are testable using this data.

5.2.1 Sex of the Respondent

The influence of sex of the respondent on perceived security is evident throughout this report. Women, as a group, feel less secure than men at all times and locations within the transit environment (Figures 13-16). They are more likely than men to say that personal security was a major factor in their decision on whether or not to use the transit system (Table 13), and fewer women than men say they did not consider security in their decision. Among nonusers of the system, the percentage of women citing security or safety problems as reasons for not using the system was somewhat larger than the corresponding figure for men (Table 23). Slightly more women than men express reluctance to use the transit system at certain times of day for reasons of security (Table 16).

Women reacted differently to the experimental change in security procedures than men did. Men felt less safe after the change, while women felt safer in the evening and at night (Figures 12-15). Women were more likely to believe that crime levels had decreased after the change (Table 19). These differences arose despite the similar experences with crime reported by men and women (Table 21) and the similar attributions of the bases for their beliefs about crime levels (Table 20).

The overall mean security ratings given by men and women are shown below with standard errors in parentheses.

	Men	Women	Difference
Survey 1	4.33 (.06)	4.64 (.06)	.31
Survey 2	4.33 (.06)	4.70 (.06)	.37

Clearly, the importance of sex as a determinant of perceived security is well established by these data, and the spread of values was underestimated in the initial model.

5.2.2 Age and Physical Condition of Respondent

The age of the respondents made very little difference in this study. Security ratings for the overall transit system did not differ for the three age groups in either survey. In rating the system attributes, differences were apparent only for frequency of service with older respondents being less satisfied on this factor in both surveys. Security ratings as a function of time and place varied by age only for the home station with older respondents feeling less secure.

The variable describing the physical condition of the respondents was not assessed in this study. Some nonusers did report that they did not use the transit system because of health problems, but there were too few such responses to analyze systematically.

5.2.3 Frequency of System Use

Ratings of personal security did depend on the frequency with which an individual reported using the transit system. Nonusers perceive the system as less safe than users, and frequent users rate it as more safe than do infrequent users (Table 18). Most nonusers cite safety and security as a major factor governing their decision about system use, while relatively few frequent users considered it a major factor (Table 14). Statistics concerning experience with crime reflect use patterns: those who use the system are more likely to witness crimes and to be crime victims (Table 22), but they are less concerned about it. Experience with crime is not directly related to the perceived security of the system. Frequent users express less fear, but they also tend not to use the system during off peak hours (Table 12).

The overall security ratings of the transit system at the time of the first survey were 4.21 for frequent users, 4.56 for infrequent users, and 5.21 for nonusers, thus the difference between the first two groups is .35, while that between the latter two is .65. The importance of this variable in the model is clearly demonstrated by the data. Its coding in the model underestimated the relative difference between users and nonusers. A more realistic coding would be:

Frequent User	1
Infrequent user	3
Nonuser	7

5.2.4 Time of Day

Three sets of evidence reveal the relationships between perceived security and time of day: (1) use patterns for the system--few people use the system between 7 p.m. and 6 a.m.; greatest use occurs in the morning and late afternoon (Table 11); (2) expressed reluctance to use the system at certain times (Table 15)--those times most people are reluctant to use the system are the times of minimum use (Table 16); (3) ratings of perceived security depend on time of day--respondents feel safer in the day than the evening and least safe at night. This holds for all groups of respondents and all rated locations (Figures 9-15).

Time of day effects were not as finely differentiated in the survey as they are in the model. But the data indicate that the scores assigned to levels of this variable are appropriate.

5.2.5 Location

Perceived security varies as a function of where in the transit system one is. The areas in and around one's home station are perceived as safer than those for a remote station at the same time of day. And the neighborhood around the home station is rated as safer than inside the home station (Figure 10). These results may be due to familiarity; we are more secure and comfortable in situations and environments with which we are familiar. But clearly urban residents have spatial maps of their cities, and these maps are partitioned into zones of differing relative safety.

When changes were made in the security procedures at a particular transit station, the effects of those changes on perceived security were localized-- they occurred only for respondents who identified the experimental site as their home station.

5.2.6 Other System Variables

Respondents rated the transit system on a series of ten system attributes. Ratings on certain of these attributes were consistently correlated with the ratings for personal security. Thus, for men the correlations of frequency of police patrol and personal security were .61 and .53 for survey 1 and 2 respectively; similar coefficients for women were .48 and .45. Correlations of personal security with condition of the stations ranged from .39 to .43, and with condition of the vehicles from .37 to .49. For men, personal security ratings correlated with system reliability ($r = .48$, in both surveys). Thus, changes in ratings of personal security are paralleled by change in ratings of other system attributes. The strongest relations are found for frequency of police patrol; people who feel such patrols are frequent enough feel safe, others don't.

5.2.7 Combination Rules

Simple linear combination rules were used in the model of perceived security to (1) combine variables into components and (2) to combine components to yield the initial security impression. In general, those rules seem reasonable in light of the relevant data. In the user component, sex of the respondents and frequency of system use appear to make independent contributions to perceived security. Direct tests of the station components were not possible in this study since only two highly similar stations were used.

In the situation component, time of day appears independent of station and location in the overall data from survey one. Thus, within the components, linear combination rules seem appropriate.

However, there were two noticeable interactions between components of the model. Frequency of system use interacted with time of day and location (see Figure 11). And, there was an interaction of sex of the respondent with the effects of the experimental change in security equipment. The first interaction does suggest that an additional term is necessary in the model to express the nonlinearity. But the linear model will provide a fairly good approximation.

The interaction of sex with the system change was not predicted. Why women changed their perceptions of personal security for the better while men changed theirs for the worse after the system change is the basic mystery in this data. Our hypothesis is as follows: at the time of the first survey, men in the area of the experimental terminal were relatively unconcerned about personal security. They were basically unaware of it, it had low salience for them. When the system change was instituted and publicized, personal security became more salient and was seen as a problem. Men appear to have concluded: "If they need to install all these gadgets, then the crime situation must be worse than I thought."

Women, on the other hand, were concerned with security from the start. They were aware of it as a problem, and it had high salience for them.

This enhanced feeling of safety was limited to the evening and night hours, but these were the times when community residents were formerly least likely to use the transit system.

6. DISCUSSION

Two models of perceived security were developed in this report: one showing the effects of perceived security on transit choice and use; the other describing the determinants of perceived security. These models represent the first attempt to systematically draw together all the components influencing perceived security in transit environments. An experiment and two surveys were done to (1) assess the effects on perceived security of an experimental crime countermeasure (CCTV), and (2) to provide data relevant to the models.

6.1 Major Survey Findings

The data from both surveys provided clear and unequivocal evidence of the role of perceived security in transit choice and use. Except where changes would be expected due to experimental conditions, the results of the second survey replicated those of the first to a remarkable degree. Most respondents in both surveys reported that they did consider security in deciding whether to use the transit system. Security was frequently cited by nonusers as a major factor in their decision not to use the transit system. In a free response item, nonusers were asked to say why they did not use the system: the most frequent reason was that it was unsafe; a substantial number of respondents also complained of sensory aggravation (i.e., noise, dirt, etc.) - a factor related to perceived security.

Almost all respondents said there were times of day during which they were reluctant to use the transit system because of concern for safety and security: these times were most often from 7 p.m. to 6 a.m. The pattern of actual system use was just the reverse of the distribution of times of reluctance to use the system: during peak traffic periods few people were reluctant to use the system; during off peak periods, many people were reluctant.

A surprising number of respondents reported personal experiences with crime: 12-16% of them had been victims of crime; 26-30% had witnessed crimes. Frequent users were more often victims or witnesses than infrequent users - which would be predicted from their greater exposure to the transit environment. However, frequent users report better levels of perceived security than infrequent users. Thus frequent users see and experience more crime but they feel more secure. Thus perceived security is not a direct function of experience with crime. Frequent users tend to use the subway system during peak traffic periods and they tend not to use it during off peak hours. These users probably feel that nothing serious will happen to them with so many other people around, but a user during an off-peak period might have greater reason to fear the more serious crimes.

Over three-fourths of the respondents in these surveys feared that they might be the victims of crime while using the subway. Personal security is a very salient concern for patrons of this transit system: it influences who uses the system and constrains the use patterns of passengers.

Perceived security varied with how often the respondent used the transit system and with the sex of the respondent. Frequent users perceived greater security than infrequent users, and nonusers felt the system was extremely insecure. Men in general, found the system more secure than women did. Age of the respondent did not seem to influence perceived security; but other factors related to age may have. Some older respondents reported that ill health and lack of need for transportation prevented them from using the system. Other older persons did report using the subway regularly. Thus, age may not be a key factor in transit use, but rather be an incidental factor correlated with physical condition and employment status. Some elderly don't use the system; it would be worthwhile knowing which variables separate those who do from those who don't, and how these variables relate to perceived security.

People identify specific times and places in the transit system as safer than others. Night hours are seen as less safe than daytime hours; the home station is safer than the central business district station; etc. These beliefs appear to be widely shared, and such systematic differences in perceived security should be the basis for allocating police patrols and surveillance equipment.

6.2 Two Models of Perceived Security

The survey data were used to check and refine aspects of the two models developed in this project. Both models proved to be very good first approximations: some changes were indicated by the survey data, but the models are basically correct.

A discriminant function model was derived to predict frequency of transit use from perceptions of various system factors: reliability, cost, convenience, comfort, personal security, etc. The values of the weights for each of these factors in the linear combination were computed from the survey data. These weights revealed the importance of perceived security quite clearly; it was the primary variable differentiating frequent users, infrequent users, and nonusers. The discriminant analysis results emphasize the importance of non-economic factors in distinguishing the user groups: those factors that were significant discriminators were: personal security, comfort, and convenience. These factors are important to transit users, but relatively little has been done to maximize them in many transit systems. Studies are needed to determine these factors trade-offs with cost, and whether improved systems would attract more riders even with greater fares.

The second type of model analyzed the determinants of perceived security, identified factors which should influence it, and proposed equations for determining perceived security given the input factors. The survey data confirmed the importance of sex of the respondents and the person's frequency of system use as determinants of perceived security. It failed to show effects due to age of the respondent. Some comments from respondents suggested that physical condition was an important consideration, but there were not many such responses.

Situation variables which proved important were location (place) in the transit system, time of day, familiarity, and by implication: user density, novelty of use, and concern for security. Station variables were not systematically varied in this research. Only two transit stations in a single system were involved, and only a single countermeasure was investigated. These stations had been selected to be as similar as possible for the experimental test. Thus, this component of the model was not tested in this study. Comments from the respondents did emphasize the importance of level of maintenance and degree of sensory aggravation as factors in system evaluation.

6.3 Findings from the Experiment

The experimental countermeasure did influence perceived security. But it only improved it for women, then only for evening and night travel. The selective effects of the crime countermeasure were explained in terms of several parameters of the model. The countermeasure effect differed depending on the salience (concern, awareness) of security to the respondent. For men, security is not a very salient issue. The security improvements function to increase their awareness of and concern for security as an issue. With women, security is already an issue, and the steps taken to improve security selectively improve perceived security for them. Working through the awareness parameter, the countermeasure helps improve perceived security for women, while decreasing it for men. Over time, we would expect that the countermeasure would also improve security for the men, but that issue can't be resolved without another survey.

These sex differences in response to the change in security procedures are reflected both in ratings of perceived security and in reports of perceived changes in crime rates at the target stations. The experimental station actually underwent two changes in security procedures in the year of this study. Several months before the experiment, a police substation was opened adjacent to the experimental station. Users, both men and women, reported no change in perceived crime levels as a result of that change. After the CCTV was installed, the changes noted above were seen: women felt more secure after this countermeasure was installed and they reported believing that crime had decreased.

Both the model and our interpretation of the results of the experiment highlight the roles of awareness, familiarity, and uncertainty in modal choice and transit use. Changes in awareness were used to explain the observed sex differences in perceived security. Further research on these constructs is necessary.

It is also necessary to do research isolating the effects of security changes from the effects of the countermeasures themselves. The result of a change may be different than that of an extant situation; putting CCTV into an existing station may affect people differently (initially) than a station with CCTV already installed would.

6.4 The Generality of These Findings and the Need for Further Research

The generality of these findings must be considered. There are several distinct products of this research and the degree of generality varies with the product.

The first product is a replicated survey on passenger security for a major urban transit system. This findings of these surveys, we feel, have a high degree of generality. They are based on two random samples from each of two neighborhoods in New York City. The results of the second survey replicated those of the first, and the results from the two neighborhoods differed only on those items relevant to the experiment. Thus, we actually have consistency among the results for four independent subsamples for most survey items. Furthermore, these results agree with those of previous studies when there is overlap between the items. Many of the hypotheses advanced as a result of the literature review were confirmed. Thus, the survey results are probably representative of those that would be obtained in any of the larger urban areas with well-established rapid rail transit systems.

The second product is an experimental test of a particular crime countermeasure (CCTV) installed in a single transit station in a major city. It is indeed "only a single transit station in New York." The results of this experiment need to be replicated, validated, and extended. How generalizable these results are is currently indeterminant; only further research can establish their generality.

This experiment however is very important in several respects. It shows how surveys of user perceptions can be used to test system innovations. It demonstrates that perceived security does vary systematically with at least one experimental change. And it shows that "subjective" data behave appropriately within the boundaries of a well-defined field experiment. The different patterns of results for the experimental and control respondents allow an unambiguous identification of what happened to perceived security as a result of the countermeasure. This study should provide a model, or standard, for doing the many studies that need to be done on perceived security.

Two obviously necessary follow-up studies should be done; (1) this same study should be done at other sites - to replicate these results and establish their generality and (2) similar studies should be conducted across different stations and transit systems. Thus, not only should further work be done in New York, but also in Chicago, Boston, Philadelphia, etc. - the results from different systems could then be compared and contrasted. Studies are also needed on (1) the long-term changes in reaction to crime countermeasures: how will users view new countermeasures after they have been installed for a year or more?, (2) the effects on perceived security of different countermeasures need to be studied, and (3) within a single system the effects of station variables should be explored.

The third product of this study is a pair of models of perceived security. The models, like the survey results, have generality beyond the experiment that was done. They were developed in light of all previous research done on perceived security, as well as drawing upon principles of perception, attitudes, evaluation, decision making and information processing from the psychology literature. They are models - as such, they provide a framework for asking questions about key issues in transit security, and give direction to further research on perceived security.

The model of the role of perceived security on transit use was derived from the data in the first survey and validated by the data from the second one. The weights for the factors in this model depend on the New York data, and might change in different situations (if the range of values of the factors were different). For example, actual cost was a constant in this study (perceived cost was not, it varied); if the cost of using the system were systematically varied, levels of cost could be found which would make perceived cost a much more potent factor in system use. Under such circumstances, the boundary conditions for the model would be different.

The model of the determinants of perceived security is different: it was not derived from the survey data, but rather developed a priori and then aspects of it were tested and confirmed by the survey data. Many other tests need to be done. The focus of such tests will be to see where to improve the model and how to change it.

Specific experiments are needed to test aspects of the model, including (1) studies of special user groups' (poor health, handicapped, etc.) views of perceived security in a variety of stations and situations, (2) studies of various station design features and their relations to perceived security, (3) studies of situational variables (crowdedness, familiarity, uncertainty, and awareness) and perceived security, (4) trade-off studies pitting countermeasures against various manpower alternatives, and (5) studies of passengers' awareness of the presence, function and consequences of crime countermeasures.

Future research should seek to validate, refine and extend these models. They should be tested more completely.

6.5 Implications of This Research

Several implications of this research and some practical recommendations should be noted:

(1) <u>It pays to have good security</u>

If you don't, ridership will be affected. If security is poor, some people will stop using the system altogether, others will minimize their use and change their trip patterns. Good security will help maintain ridership at high levels.

(2) To attract certain audiences, special measures are necessary

This implies that different marketing strategies should be followed to attract different groups of people to the system. In order to encourage higher offpeak system use, it is necessary to emphasize security provisions in appealing to infrequent users. Other user differences suggest other appeals.

(3) Make people aware of what you are doing to provide security

Countermeasures improve perceived security only if users are aware of them. Furthermore, some people feel safer knowing that something is being done. People should be made aware of the countermeasures, their operation, and the possibilities inherent in their use.

(4) With a surveillance system, remind users that the stations are being watched

Periodic announcements over a PA system, occasional comments or observations about happenings in the station will keep users aware of surveillance. Detected incidents should be handled promptly: minor ones with a warning over the PA; more serious ones by dispatching a police officer to the scene. Users must believe that they can get help when they need it.

(5) Provide selective security force

People feel safer at certain times and places than at others. Police patrols and extensive security hardware should be provided at those times and places that riders view as dangerous. Security effort should match the need for that security. Selective treatment of stations, saturation patrols, and patrols during offpeak hours are all reasonable operational policies, and are likely to be appreciated by the security conscious transit user.

7. REFERENCES

Anderson, N. H. Information integration theory: a brief survey. P. 236-297 In Krantz, D., Atkinson, R. C., Luce, R. D., and Suppes, P., Contemporary Developments in Mathematical Psychology, Volume II. San Francisco, W. H. Freeman, 1974.

Broad and Columbia Subway Study Group, Broad and Columbia Subway Development Study. Philadelphia City Planning Commission and the U. S. Department of Transportation, 1971.

Carnegie-Mellon University, Security of Patrons on Urban Public Transportation Systems, Workshop on Transit Security, Pittsburgh, PA, February 24-25, 1975.

Carroll, J. D. Individual differences and multidimensional scaling, 1972, In Shepard, R., Romney, A., and Nerlove, S. Multidimensional Scaling, Volume I. New York: Seminar Press, 1972.

Cliff, N. The "Idealized Individual" interpretation of individual differences in multidimensional scaling. Psychometrika, 33, 1968, 225-232.

Coombs, C. A Theory of Data. New York: Wiley, 1964.

Costantino, D., Golob, T., and Stopher, P. Consumer preferences for automated public transportation systems. Transportation Research Board Report 527: Travel Behavior Analysis. Transportation Research Board, Washington, DC, 1974.

Demetsky, M. J., Hoel, L. A. and Virkler, M. R. Methodology for the Design of Urban Transportation Interface Facilities. Final Report, DOT-TSC-77-46, December 1976.

Dobson, R., Golob, T., and Gustafson, R. Multidimensional scaling of consumer preferences for a public transportation system: an application of two approaches. Socio-Economic Planning Sciences, 8, 1974, 23-36.

Dobson, R. and Kehoe, J. Disaggregated behavioral views of transportation attributes. Transportation Research Record 527: Travel Behavior Analysis. Transportation Research Board, Washington, DC, 1974.

Feldman, L. P. and Vellenga, D. B. The role of security in marketing urban mass transit. High Speed Ground Transportation, 1976.

Ferarri, N. D., and Trentacoste, M. F. Personal security on public transit. Transportation Research Forum, 15th Annual Meeting, Volume XV, No. 1, 1974.

Foerster, J. F., Young, F., and Gilbert, G. Longitudinal changes in public attitudes toward a new transit system, presented at the Annual Meeting of the American Psychological Association, Chicago, IL, 1975.

Harris, O. L., Jr. A Methodology for Developing Security Design Criteria for Subways. Transportation Research Institute, Carnegie-Mellon University. Pittsburgh, PA. October 1971.

Hoel, L. A. and Roszner, E. S. Transit Station Planning and Design: State of the Art. Transportation Research Institute, Carnegie Mellon University. Pittsburgh, PA. January 1975.

Institute of Urban and Regional Development, University of California, Berkeley, BART-1: Traveler Behavior Studies Part II, Vol. II, BART Traveler Environment: Environmental Assessment Methods for Stations, Lines and Equipment. Final Report to Metropolitan Transportation Commission, Berkeley, CA. May 31, 1973

Jacobson, I. and Martinez, J. The comfort and satisfaction of air travelers--basis for a descriptive model. Human Factors, 16, 1974, 46-55.

Jacobson, I. D., and Richards, L. G. Ride quality evaluation II: modeling of airline passenger comfort. Ergonomics, 19, 1976, 1-10.

Jacobson, I.D., Richards, L.G., Leiner, C.T., Hoel, L.A., and Braden, A. AGT System Safety and Passenger Security Study. Passenger Security Guidebook. Final Report, DOT-TSC-UMTA-80-1/UMTA-MA-06-0048-79-7. March 1980.

Kinget, G. M. On Being Human. New York: Harcourt Brace Jovanovich, 1975.

Levin, I. P. Information integration in transportation decisions, In Kaplan, M. and Schwartz, S. (eds)., Human Judgment and Decision Processes. New York: Academic Press, 1976.

Nicolaidis, G., and Dobson, R. Disaggregated perceptions and preferences in transportation planning. Transportation Research, 9, 1975, 279-295.

Olsen, William T. Psychological implication of public transportation service. Florida State University Transportation Center, January 1973.

Richards, L. G. and Jacobson, I. D. Ride quality evaluation I: questionnaire studies of airline passenger comfort. Ergonomics, 18, 1975, 129-150.

Richards, L G., Jacobson, I.D., and Ransone, R. K. Factors in modal choice for short out-ofptown trips, 1978, University of Virginia, Charlottesville.

Shellow, R., Romualdi, J., and Bartel, E. Crime in rapid transit systems: an analysis and recommended security and surveillance system. Crime and Vandalism in Public Transportation, Research Record #487.

Siegel, L., Molof, M., Moy, W., Strack, J. and Jordon, F., Jr. An assessment of crime and policing responses in urban mass transit systems. The Mitre Corporation, April 1977.

Sinha, K. C., and Roemer, F. P. Personal security in buses and its effect on ridership in Milwaukee. Transportation Research Record #487: Crime and Vandalism in Public Transportation. Transportation Research Board, Washington, D.C., 1974.

Tatsuoka, M. Discriminant Analysis: The Study of Group Differences. Champaign: IPAT, 1970.

Tatsuoka, M. Multivariate Analysis. New York: J. Wiley & Co., 1971.

Thrasher, E. J., and Schnell, J. B. Studies of public attitudes toward transit crime. Transportation Research Report #487: Crime and Vandalism in Public Transporation. Transportation Research Board, Washington, D.C., 1974.

Tucker, L. R. Intra-individual and inter-individual multidimensionality In Gulliksen, H., and Messick, S. (eds.), Psychological Scaling: theory and applications. New York: Wiley, 1960, pp. 155-167.

Tucker, L. R., and Messick, S. An individual differences model for multidimensional scaling. Psychometrika, 28, 1963, 333-367.

Zakaria, T. Analysis of urban transportation criteria. Transportation Engineering Journal, 1975, 521-536.

APPENDIX A

Survey Materials

DUNLAP and ASSOCIATES, INC. • One Parkland Drive • Darien, Connecticut 06820

Transit Systems Survey

ADVANCE NOTICE

In a few days you will receive a letter from us requesting your feelings about the subway system near your home. Please plan to let us know what you think.

Sincerely yours,

Richard D. Pepler, Ph. D.
Project Director

(Contract No. DOT-TSC-1314, U.S. Dept. of Transportation)

Mailing No. 1--Post Card of Advance Notice (Mail on Day 1)

Transit Systems Survey

DUNLAP and ASSOCIATES, INC.

EASTERN DIVISION

ONE PARKLAND DRIVE, DARIEN, CONN. 06820 • 203-655-3971

Dear Neighbor:

Here is the letter we notified you about a few days ago. Your feelings about the subway system near your home are of concern to the U.S. Department of Transportation. Under Federal Contract, we are contacting you and some of your neighbors to obtain information that can help make the system a better one.

We want ideas from adults of all ages. Since we do not know the ages of people in your household, we request that you have this form filled out by the one who is closest to age 45 (and at least 18). Do not be concerned if there is a big difference between that person's age and the requested age. Because we are also questioning some of your neighbors in different age groups, we expect a good overall cross-section to be represented in the final results.

Please return the completed form using the enclosed postage-free envelope. To be included in the survey, the form must be received as soon as possible in the month of January 1978.

We hope you find this to be an interesting experience, and thank you for taking part in this most important project.

Sincerely,

Richard D. Pepler, Ph.D.
Project Director

(Contract No. DOT-TSC-1314, U.S. Dept. of Transportation)

Mailing No. 2--Cover Letter for Questionnaire (Mail on Day 5)

Transit Systems Survey

DUNLAP and ASSOCIATES, INC.
EASTERN DIVISION
ONE PARKLAND DRIVE, DARIEN, CONN. 06820 • 203-655-3971

Dear Neighbor:

About a week ago, we sent you a form on which you could let us know what you think about the subway system near your home. As of the time this letter is being mailed we have not heard from you, so we are sending you another form on the chance that you misplaced or never received the first one.

As you may recall, we are requesting that you have this form filled out by the person in your household who is closest to age [illegible] (and at least 18). Do not be concerned if there is a big difference between that person's age and the requested age.

Please return the completed form using the enclosed postage free envelope as soon as possible in the month of January 1978.

We hope that you find this experience to be an interesting one, and thank you for taking part in this important project.

Sincerely,

Richard D. Pepler, Ph. D.
Project Director

(Contract No. DOT-TSC-1314, U.S. Dept. of Transportation)

Mailing No. 3--Cover Letter for Second Questionnaire (Mail on Day 12)

DUNLAP and ASSOCIATES, INC. • One Parkland Drive • Darien, Connecticut 06820

Transit Systems Survey

FINAL REMINDER

In the past couple of weeks we sent you a form on which you could let us know your feelings about the subway system near your home. If you have not yet filled it out and sent it back to us, please do so as soon as possible. Your feelings are important!

Sincerely yours,

Richard D. Pepler, Ph. D.
Project Director

(Contract No. DOT-TSC-1314, U.S. Dept. of Transportation)

Mailing No. 4--Final Follow-Up Post Card (Mail on Day 22)

In agreement with the U. S. Department of Transportation, the completed questionnaires have been destroyed to protect the privacy of the respondents. These questions were solely for the purpose of statistical analysis and model building and not for the evaluation of the New York City Transit System.

Transit Systems Survey

DUNLAP AND ASSOCIATES, INC.
One Parkland Drive, Darien, Connecticut 06820

No. 004-S-77003

Nº 6094

How do you feel about your subway system? You represent a part of the public opinion which is being surveyed by the firm of Dunlap and Associates, Inc., under contract with the U.S. Department of Transportation. Please mark down your answers to the following questions. Your answers are vital to the planning of new transportation systems.*

You need not answer any question that offends you.

1. How often have you used the subway system in the last year?

   ______Daily ______A few times in the last year

   ______A few times a week ______Never used it

   ______A few times a month

   If you have never used the system, please go to Item 3.

2. If you did use the subway system, please answer Items a through e:

   a. At what times of day did you usually use the subway system?

   ____

   b. Did you ever use the subway in the evening (after 6:00 p.m.)?

   ______Yes ______No

   c. Did you ever use the subway early in the morning (before 5:30 a.m.)?

   ______Yes ______No

   d. For what purposes did you most frequently use the subway?

   ______Trips to and from work ______Social or recreational trips

   ______Trips to and from school ______Other ______________

   ______Shopping trips

   e. From which station did you usually enter the subway system?

   ____

   f. How far is the station from your home (in city blocks)?

   ____

   Please go on to Item 4.

3. If you did not use the subway system, please tell us the reasons why you did not use it?

   ____

   ____

   ____

   ____

*This report is authorized under Law 49 U.S.C. 1605. While you are not required to respond, your cooperation is needed to make the results of this survey comprehensive, accurate, and timely.

PLEASE ANSWER ALL OF THE REMAINING ITEMS.

4. Considering your subway system as a whole, how would you rate it with respect to personal security?

VERY SECURE	SECURE	SOMEWHAT SECURE	SOMEWHAT UNSECURE	UNSECURE	VERY UNSECURE
☐	☐	☐	☐	☐	☐

5. Please answer the following questions, even if you never use the subway system.

For each of the following 10 characteristics, use a check mark ☑ to show how good or bad you think the subway system is.

	VERY GOOD	GOOD	FAIR	POOR	BAD	VERY BAD
RELIABILITY, dependability, on-time operation	☐	☐	☐	☐	☐	☐
CONVENIENCE, accessibility	☐	☐	☐	☐	☐	☐
PERSONAL SECURITY from crime	☐	☐	☐	☐	☐	☐
COST, reasonableness of fare	☐	☐	☐	☐	☐	☐
CONDITION OF VEHICLES, cleanliness, state of repair	☐	☐	☐	☐	☐	☐
FREQUENCY OF SERVICE, scheduling	☐	☐	☐	☐	☐	☐
COMFORT	☐	☐	☐	☐	☐	☐
SAFETY from accidents	☐	☐	☐	☐	☐	☐
FREQUENCY OF POLICE PATROL	☐	☐	☐	☐	☐	☐
CONDITION OF STATIONS, cleanliness, state of repair	☐	☐	☐	☐	☐	☐

Are there times of day or night when you would not use the subway because of concern for your personal security? ______ Yes ______ No

If you answer "yes," please list any times you would avoid the system: ____________________

____

____

7. We would like to know how secure you would feel on the New York subway system at several places and times. For each place and time indicated below, please check the box corresponding to how secure you would feel in that situation.

	VERY SECURE	SECURE	SOMEWHAT SECURE	SOMEWHAT UNSECURE	UNSECURE	VERY UNSECURE
● Inside "YOUR LOCAL STATION:"						
During the day? (7:00 a.m.-6:00 p.m.)	☐	☐	☐	☐	☐	☐
In the evening? (6:00 p.m.-9:00 p.m.)	☐	☐	☐	☐	☐	☐
At night? (9:00 p.m.-7:00 a.m.)	☐	☐	☐	☐	☐	☐
● In your neighborhood surrounding the station:						
During the day? (7:00 a.m.-6:00 p.m.)	☐	☐	☐	☐	☐	☐
In the evening? (6:00 p.m.-9:00 p.m.)	☐	☐	☐	☐	☐	☐
At night? (9:00 p.m.-7:00 a.m.)	☐	☐	☐	☐	☐	☐
● Now consider the 14th Street (Manhattan) station. In general, would you feel secure or unsecure in the 14th Street station:						
During the day? (7:00 a.m.-6:00 p.m.)	☐	☐	☐	☐	☐	☐
In the evening? (6:00 p.m.-9:00 p.m.)	☐	☐	☐	☐	☐	☐
At night? (9:00 p.m.-7:00 a.m.)	☐	☐	☐	☐	☐	☐
● In the neighborhood surrounding the 14th Street station:						
During the day? (7:00 a.m.-6:00 p.m.)	☐	☐	☐	☐	☐	☐
In the evening? (6:00 p.m.-9:00 p.m.)	☐	☐	☐	☐	☐	☐
At night? (9:00 p.m.-7:00 a.m.)	☐	☐	☐	☐	☐	☐

8a. Do you think that, in the past six months, the level of crime at "YOUR LOCAL STATION" has: (please check one)

______ Decreased a lot______, or a little ______

______ Remained about the same

______ Increased a lot______, or a little ______

8b. If you feel there has been a change in the crime level what do you think caused it?

____

____

____

9. Is this belief based on:

a. Your own personal observations and experiences? ______ Yes ______ No

b. Media coverage (TV, radio, newspapers, magazines)? ______ Yes ______ No

c. Discussions with friends, relatives or family members? ______ Yes ______ No

d. Other sources? ______ Yes ______ No

If Yes, please specify: ____

____

10. In the past year, have you:

a. Witnessed a crime while using the subway system? ______ Yes ______ No

If Yes, please describe: ____

____

____

b. Been a victim of a crime or attempted crime while using the subway system? ______ Yes ______ No

c. Heard of a friend, relative or co-worker having been the victim of a crime or attempted crime while using the subway system? ______ Yes ______ No

d. Feared that you might be the victim of a crime while using the subway system? ______ Yes ______ No

To allow us to combine your answers with those of other people, your answers to the following questions are needed. They will be used for statistical purposes only, and will not be disclosed or used in any other manner.

11. Sex: ____ Male ____ Female

12. Age (approximate) ________

13. What is your occupation? ____

14. Approximate total family income (before taxes):

______ Under $ 5,000 ______ $20,000 – $24,999

______ $ 5,000 – $ 9,999 ______ $25,000 – $29,999

______ $10,000 – $14,999 ______ $30,000 – $34,999

______ $15,000 – $19,999 ______ $35,000 +

15. How many personal vehicles (cars, pickups or vans) are available for daily use by members of your household? ____________________

16. Do you have a valid driver's license? ______ Yes ______ No

If you answered No to question 16, you may skip to question 18.

17. Do you drive frequently? ______ Yes ______ No

18. Do you consider personal security in deciding whether or not to use the subway system?

______ Yes, it is the major factor in my decision

______ Yes, it is one of several important factors

______ No, I do not consider it

______ I don't know

APPENDIX B

CCTV System Installation and Evaluation

1. BACKGROUND

A. Rationale for the Study

Existing AGT systems, servicing as they do special populations and operating mostly in restricted non-urban settings, have not encountered very serious security problems. However, security is currently a major problem for most large urban transit systems. The reduction in numbers of system personnel (drivers, conductors, station and ticket booth attendants), and the increase in numbers of unmanned stations and driverless small vehicles will add greatly to the problems of ensuring passenger security in the urban environment.

Crime and vandalism are blamed for reducing ridership on mass transit systems. A study of four crime categories--crimes against the person, crimes against personally carried property, crimes against station property, and crimes against the public--and the appropriateness of countermeasures in each major category were studied. It is hoped that future AGT systems will provide the kind of actual and perceived security that will encourage people to use the systems.

To help in learning how to optimize the security of future transit systems, a small countermeasure experiment was planned on an existing system. With the cooperation of Chief Sanford D. Garelik of the NYC Transit Police, the evaluation of an experimental closed circuit television surveillance system was completed. Data on crime, ridership and perceptions of passenger security were collected both at an experimental site in Queens and at a matching control site in Brooklyn, New York.

B. Site Selection

The PATCO and BART systems were the first ones to be considered as sites for conducting the experiment. It quickly became apparent that the PATCO system is relatively small and has very few crimes that are considered relevant to this study. Of the small number of crimes committed on PATCO, most relate to fare evasion (in the downtown stations) or automobile vandalism (in the parking lots of rural stations). For the BART system, we found that our experiment schedule was incompatible with the crime countermeasures experiment being conducted by BART personnel. They were replacing attendants at two stations with CCTV systems for a 60-day period some time prior to our scheduled experiment. Other difficulties with using the BART system included the extra costs and inconvenience associated with the long distance between Darien, Connecticut and San Francisco, California.

As a result of the less than optimal circumstances associated with conducting our experiment on the PATCO or BART systems, we enlarged our search to also include: PATH, NYCTA, MBTA and WMATA. A summary chart of our findings is seen in Table 1. Evaluation criteria were applied to each system to aid in selecting the best system for our purposes. One of the more serious reasons for dropping the PATH and MBTA systems from further consideration was the apparent lack of interest and desire to cooperate by the system administrators. We dropped the WMATA system from consideration because it was too new to have a stabilized crime history, it was not operational over its full length, it was manpower intensive in security at that time, and there was a lack of interest by its administrators in our proposed modifications. This left the NYCTA system, in which we found the greatest interest and desire to cooperate on the part of Transit Police Chief Sanford D. Garelik, a significant amount of crime for the system as a whole, existing data and data collection procedures, and the convenience of being about a one hour drive from our Darien offices. Following several meetings and discussions between NYCTA Police, TSC and Dunlap and Associates, Inc., Chief Garelik offered us the use of the Beach 116th Street Station in Rockaway Park (Queens) as the experimental site. Although the actual crime level is low there, Chief Garelik emphasized that the perception of crime is so significant as to have produced complaints to his office from members of the community around that station. The station serves a community that presents several characteristics important for our study. It is typical of many commuter-type stations throughout the country. It includes both a small business and large residential area where many residents own cars and can choose between public and private transportation. It attracts summer vacationers and is near an amusement area that attracts persons from all over the city. Also, because of the proximity of a Transit Police district headquarters, the experiment was conducted without adding police personnel or any other operating costs.

Chief Garelik assigned Detective Bernard Jacobs to assist us in the implementation of the experiment. In a meeting with Detective Jacobs, his associate, Detective James McHugh, and the Commanding Officer of the District Office, Captain Charles Mills, those police officials unanimously agreed upon a second site, Rockaway Parkway (Brooklyn), as being the best choice for a control site. This recommendation was made on the basis that the Brooklyn station most closely resembles the Queens station in terms of its location, physical environment, local population characteristics and adjacent

TABLE B-1. EVALUATION OF SYSTEMS FOR CM EXPERIMENT AND SURVEY

Criteria \ Systems	PATCO	BART	PATH	NYCTA	MBTA	WMATA
1. Appropriate crimes of interest	5	3	2	1	1	5
2. Appropriate levels of crime to measure CM impact	5	4	2	1	1	5
3. Interest expressed by transit officials	1	2	4	1	4	2
4. Existing, stablized data bases and collection procedures	1	2	3	1	3	5
5. Convenience and practicality for managing the experiment	3	5	1	1	3	3
6. Economy of operation to meet budget	2	5	1	4	3	3
7. Timely match with transit system CM experiment	5	5	5	2	4	5
8. Similarity to AGT System	2	2	3	5	4	1

1. Excellent	4. Poor
2. Good	5. Very Poor (or unknown)
3. Fair	

neighborhood along the train route. Each station is the terminus of its respective train route. Figure 1 is a map of the NYCTA area encompassing the two sites. Table 2 is a comparison of their features. Census tracts including about 15,000 people around each site were identified for use in the questionnaire survey associated with this experiment.

The CCTV/Audio installation at the Rockaway Park station is the first to be installed on the New York subway system. Plans are now in existence for other CCTV/Audio systems at 57th Street/Avenue of the Americas, 59th Street/Columbus Circle and the Times Square/42nd Street/Eighth Avenue complex. (The next installation is expected in the fall of 1979 at 57th Street/Avenue of the Americas.)

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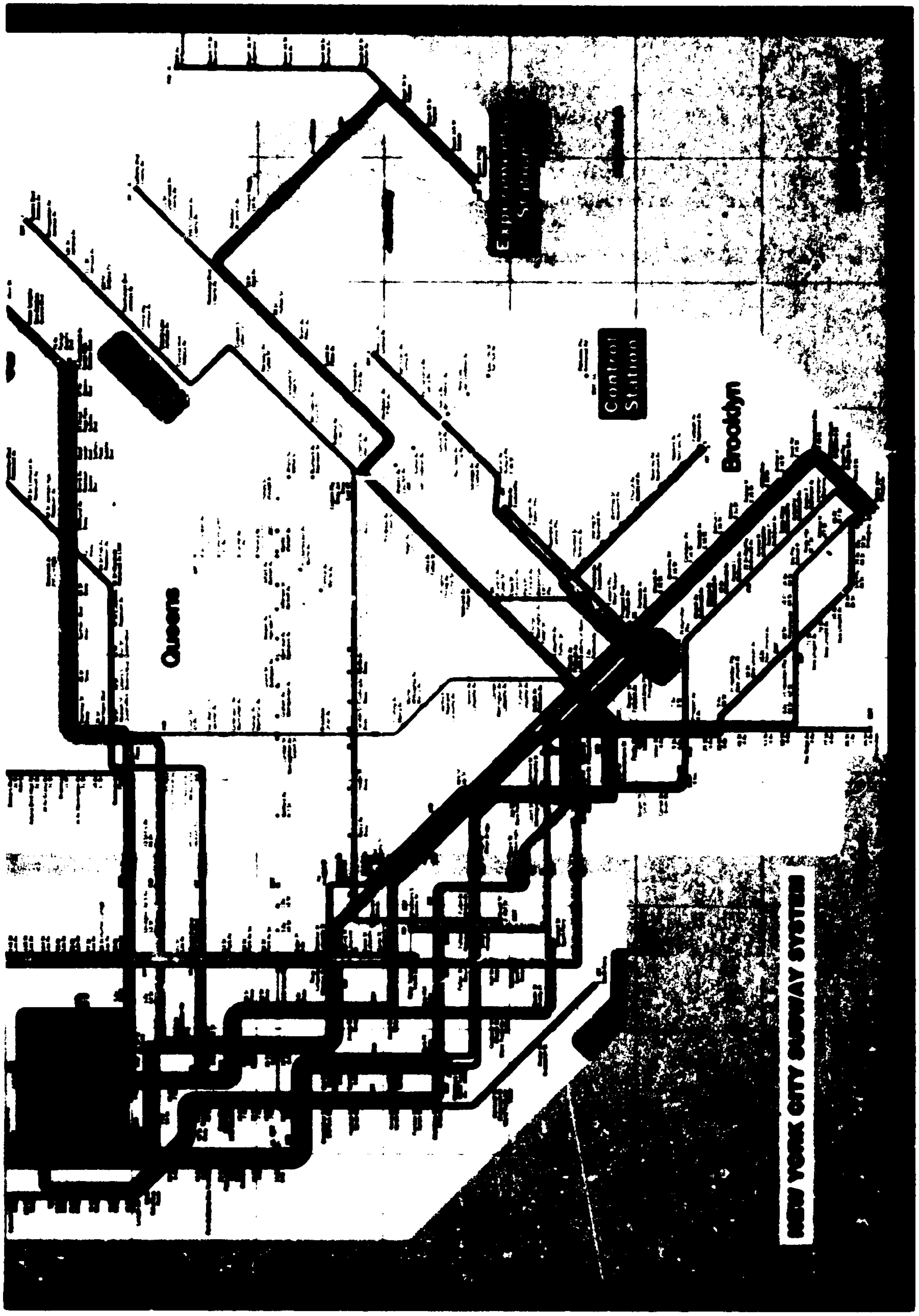

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FIGURE B-1. NYCTA MAP

TABLE B-2. COMPARATIVE FEATURES OF THE EXPERIMENTAL SITE AND THE CONTROL SITE

Features	Beach 116th Street Station	Rockaway Parkway Station
a. Role in experiment	Experimental Site	Control Site
b. Station elevation and entry	Street level	Street level
c. Station components	Large waiting room, large outside ramp, one outside platform with roof	Small waiting room, small outside ramp, one outside platform with roof
d. Station type	Terminus of Rockaway Line	Terminus of 14th Street/Canarsie Line
e. Neighborhood	Residential with small stores, middle class	Residential with small stores, middle class
f. Adjacent neighborhood along train route	Higher crime, "ghetto" area	Higher crime, "ghetto" area
g. 1970 U.S. Census Tracts around the station	Nos. 0922, 0928, 0934	Nos. 0962, 0964, 0966, 0968, 0970, 0974, 0988, 0990, 0992
h. Total population in census tracts (1970)	14,421	15,096
Negro (%)	50 (0.35%)	53 (0.35%)
Spanish Speaking (%)	129 (0.89%)	459 (3.04%)
i. Age Groups (selected)		
15-19 years (% of total)	1111 (7.70%)	1211 (8.02%)
25-34 years (% of total)	1293 (8.97%)	1715 (11.4%)
45-54 years (% of total)	1934 (13.4%)	2227 (15.1%)
65-74 years (% of total)	1751 (12.1%)	1060 (7.02%)

(continued)

TABLE B-2. COMPARATIVE FEATURES OF THE EXPERIMENTAL SITE AND THE CONTROL SITE (CONTINUED)

Features	Beach 116th Street Station	Rockaway Parkway Station
j. Number of Workers (% of all persons)	5267 (36.5%)	6274 (41.6%)
k. Workers using subway or elevated train (% of all workers)	1252 (23.8%)	2901 (46.2%)
l. High School and College Students (% of all persons)	1586 (11.0%)	1357 (9.0%)
m. Mean 1969 family income (number of families)	$18,402. (3915)	$10,568. (4330)
n. Number of all year-round housing units	5360	5033
o. Actual crime level	Low	Low

Source of data for features 'g' through 'n': 1970 Census of Population and Housing, Report No. 145, Tract Statistics for New York, New York, Bureau of Census, U.S. Department of Commerce, Washington, D.C.

2. EXPERIMENTAL DESIGN AND PROCEDURES

A. General

The procedures for carrying out the crime countermeasures experiment included equipment procurement and installation, operation for the experimental period (until approximately June 1978), publicity and public relations activities, data collection and analysis. Since this experiment was used also to test the passenger value structure model, all of the procedures were coordinated with the survey requirements of that task. A security perception survey was scheduled for completion before installation or any public announcements about the countermeasures system. A second survey was scheduled for completion after the system was operating for some time. One thousand households in each location, experimental and control, were scheduled to be surveyed via mail questionnaires before installation, and an equal number of other households were scheduled to be surveyed afterwards. A total of 4,000 questionnaires were involved.

B. Equipment Specification and Procurement

In discussions over several months involving our project staff (at Dunlap and Associates, Inc., and the University of Virginia) with personnel at DOT/TSC and NYC Transit Police, it was concluded that a closed circuit television (CCTV) system in combination with an audio system would be an appropriate and practical countermeasure to use in the experiment.

A site examination by NYC Transit Police and Dunlap and Associates, Inc. project staff was conducted in early October 1977 for the purpose of specifying a preliminary layout of required CCTV and audio equipment. We also determined the names of three firms that have had prior dealings with the NYC Transit Police on the subject of CCTV. Figure 2 shows the final determination for positioning all the equipment required for this experiment. Included are: eight cameras with appropriate environmental and tamper-proof housings; four outdoor speaker-microphone units; eight 10-inch TV monitors (one for each camera); one video tape recorder with ten cassettes; a time and date generator to provide required notations on the recordings; a 17-inch TV monitor to view whatever is being recorded on the VTR; a camera selector control box with manual and automatic sequencing capability for use with the VTR; a speaker-microphone control box with individual or group selection capability; a microphone; and all necessary cables and mounting hardware.

A summary of requirements for the specified system was sent to the three CCTV suppliers referenced earlier. The final award, based upon the lowest price, was given to GBC Closed Circuit TV Corporation, presently (but not then) of 315 Hudson Street, New York, New York 10013.

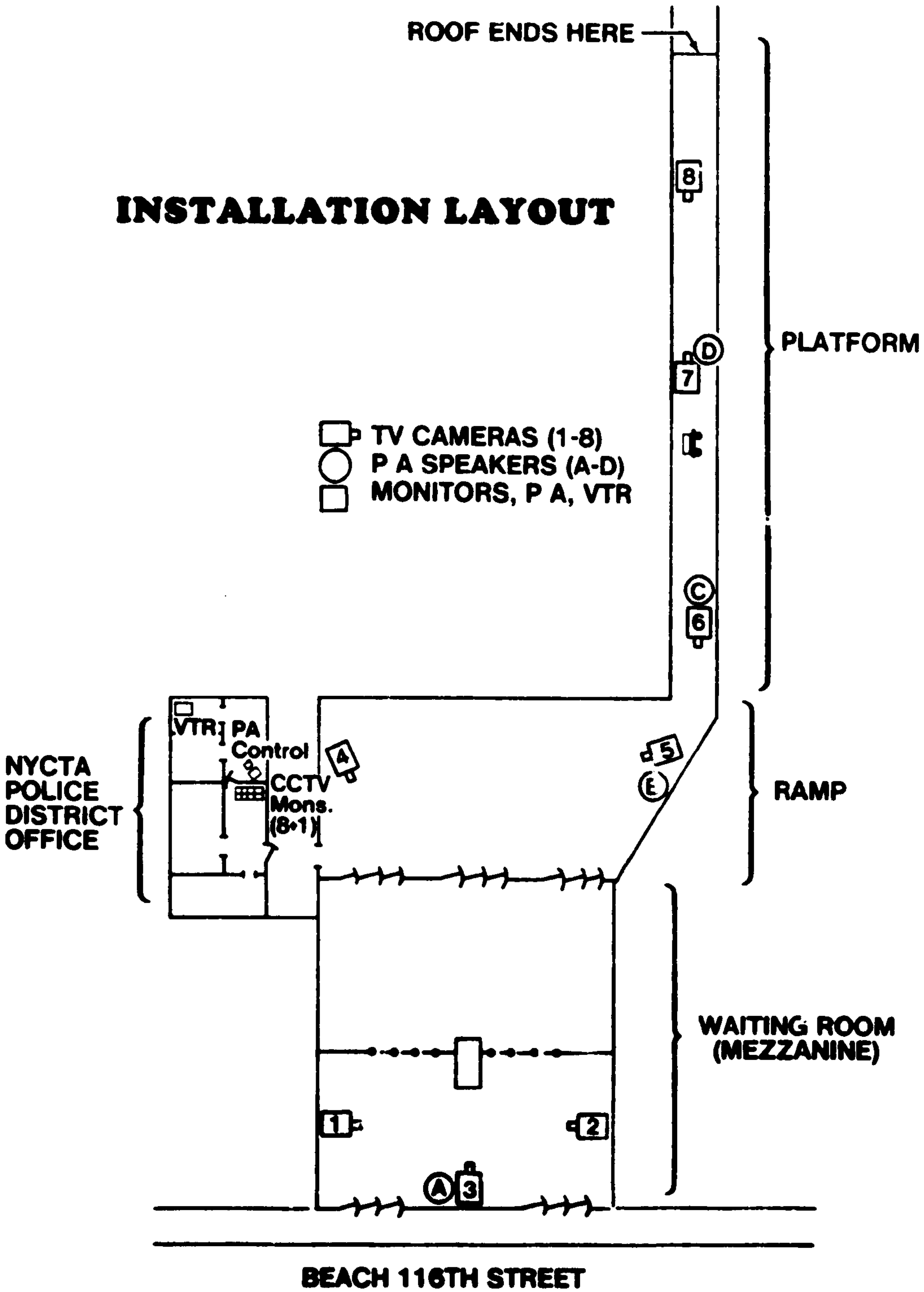


FIGURE B-2. INSTALLATION LAYOUT

C. Criteria for Evaluation

This experiment was intended to demonstrate the extent to which a widely publicized and visible monitoring system affects the actual and perceived sense of security at the station. Because of the relatively brief time period available (see F. Schedule and Key Events), it was considered unlikely that significant effects of the countermeasures installation would be measurable during the period of the study. However, various kinds of data were planned for collection and review. Those data include statistics and anecdotal reports associated with the experimental and control sites, taken before and after the countermeasures system installation at the experimental site. Interest was in the statistics of actual crimes in and around the station (including local precinct data), systemwide crime statistics, ridership, equipment performance (e.g., down time), police incident reports at the stations (including vandalism of the countermeasures installation), and evaluations or reactions by riders, other local residents, and the transit police personnel.

D. Procedures for Operation

The CCTV and audio installation was and is controlled and operated by NYC Transit Police personnel at the Desk Officer's location in the District Office. The eight cameras and four loudspeakers are located as shown approximately in Figure 2. TV monitors, a video tape recorder (with separate monitor) and a video selector switch for the recorder input are located near the Desk Officer within reach, as appropriate. The Desk Officer also has a desktop microphone, audio amplifier and selector switch for speaking over any or all of the loudspeakers. He monitors all the audio surveillance microphones simultaneously. The system operates on a 24-hour a day basis, every day. Periodic statements are made over the audio subsystem to establish and reinforce public awareness that the system is actually working and in use. Arrangements exist for notifying the equipment supplier whenever an equipment or system malfunction occurs, and temporary replacement equipment is to be installed when possible if lengthy repair times are required.

Prior to system operation, the need for confidentiality about the countermeasures installation was emphasized, so that the perception survey would not be biased by respondents having advance information. Upon installation and the beginning of operations, publicity about the countermeasures installation at the station was carried out by the NYC Transit Police Department. Widespread knowledge of the installation was obtained through all media, including newspapers, radio, television and posted signs. Interviews with the media and other public relations activities were conducted in coordination with the NYC Transit Police Department.

Once continuing operation began, a separate system log book was set up and maintained by Captain Nicholas Bole, the new Commanding Officer of the District 23 Transit Police Headquarters. The log book for noting CCTV/ Audio system items is a supplement to the Police Blotter which continues in use as the primary record-keeping instrument of the Desk Officer.

In ordinary use, the Desk Officer would maintain a continuous audio surveillance of the station, using the speaker system, while he carried out his other duties. Although he would scan the TV monitors from time to time, he would make a specific examination of activities on the TV monitors upon hearing unusual sounds or commotion over the loud speaker. In addition to issuing instructions over the speaker system, he would also be available to go out to the disturbance location as a means of following through with appropriate police action.

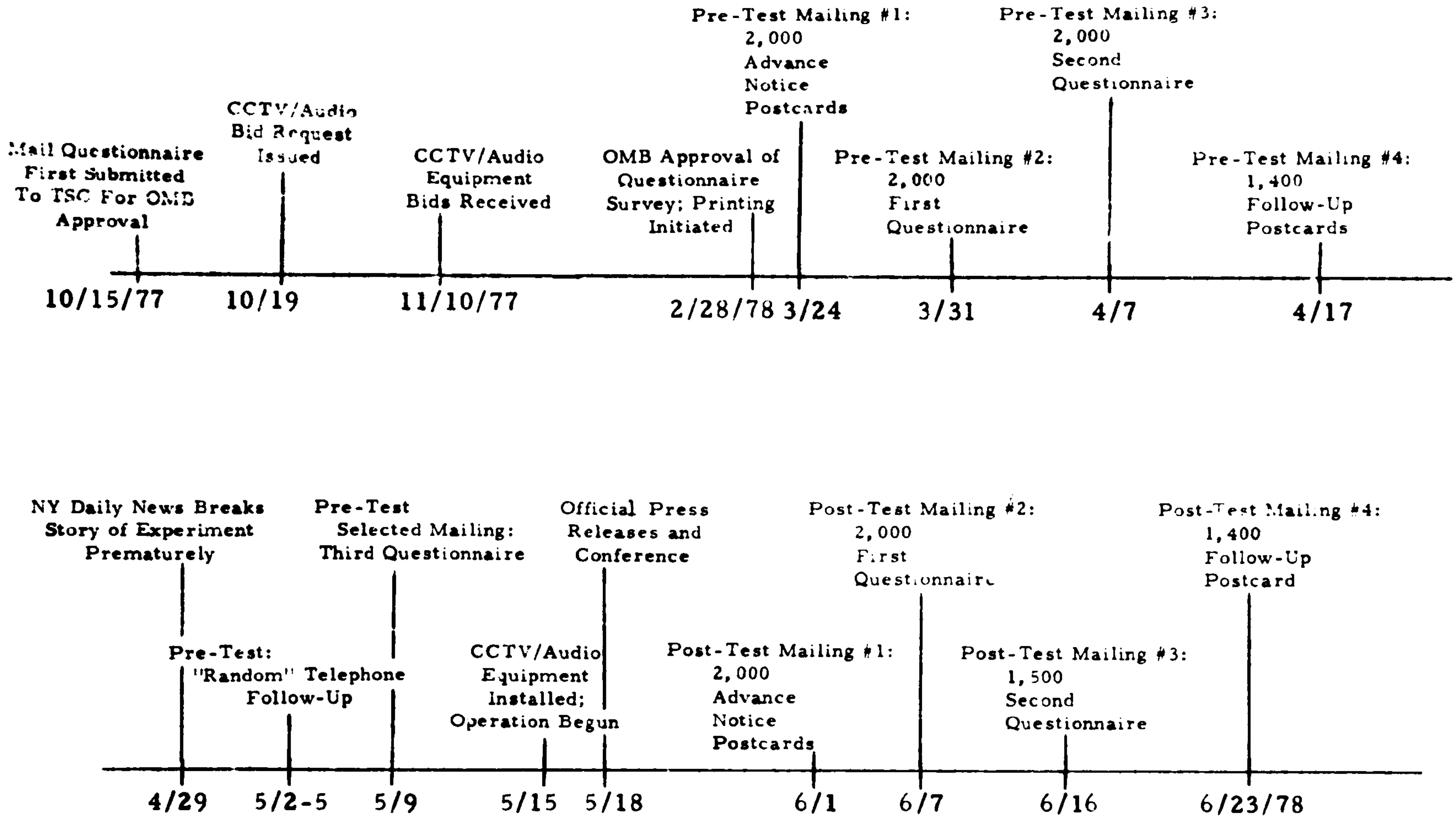
E. Data Collection

Data were collected for the experimental and control sites from the NYC Transit Police, from other civilian personnel of the NYCTA, and from the survey of passengers and non-passengers. The Transit Police, with Chief Garelik's authorization, provided a record of the District 23 log book entries on incidents resulting from the CCTV/Audio surveillance and on equipment performance. The Transit Police also provided anecdotal comments regarding how they used the equipment and how they feel about it. Data on crimes, both in and around the experimental and control stations, were obtained for us by Chief Garelik's official aide, former Chief Inspector Sydney C. Cooper. Ridership statistics, based on turnstile records at the experimental and control sites, were provided by Mr. Bernard Hyman, a civilian employee of the NYCTA. Passenger and non-passenger perceptions of security at the experimental and control sites were developed by our project staff at the University of Virginia from mail survey questionnaires administered to experimental and control station area residents by our project staff at Dunlap and Associates, Inc.

F. Schedule and Key Events

Figure 3 illustrates the sequence of various key events which occurred during the crime countermeasures experiment. It also includes the coordinated events of the mail questionnaire survey.

The key synchronizing event for the coordinated efforts was OMB approval of the mail questionnaire. The completion of the pre-test mail survey was necessary prior to installation and operation of the countermeasures equipment. In mid-October 1977, the mail questionnaire and a supporting statement was first submitted to TSC for OMB approval. It described a set of four mailings, including the questionnaire, to be sent to each respondent. The first mailing consisted of a post card of advance notice; the second was the questionnaire with a cover letter and postage-free return



FIGUURE B-3. SCHEDULE OF KEY EVENTS IN THE COUNTERMEASURE EXPERIMENT envelope to be sent about four days later; the third was a duplicate questionnaire, cover letter and envelope to be sent about seven days later; and the fourth was a follow-up post card to be sent about ten days later. The questionnaire survey materials were set to be produced and mailed as soon as OMB approval was obtained. That approval was received on 28 February 1978.

Printing of the survey materials was initiated immediately upon receipt of the OMB approval; selection of the sample and printing of mailing labels had already been completed in January. The time required for printing, plus the spaced mailing of four cards and letters to each addressee, plus waiting time for responses, placed the earliest expected completion of the pre-test survey at the end of April. The CCTV/Audio equipment was to be installed immediately thereafter. On March 15, a meeting was held at the Beach 116th Street Station for the purpose of initiating and coordinating the installation of the CCTV and audio countermeasures equipment. The meeting was attended by representatives of Dunlap, NYC Transit Police, NYCTA Power Department, and GBC Closed Circuit TV Corporation. Final equipment locations were selected and arrangements were made for power lines to be installed by April 30, so that the countermeasures equipment could be installed on May 1 (following completion of the pre-test mail survey).

In a premature report on April 29, the New York Daily News revealed the existence of this experiment. In their article of almost 350 words in length, the reporter noted the involvement of DOT, NHTSA and Dunlap and Associates, Inc., and he described the experimental site in Rockaway Park as a "safe" subway station. He indicated that a survey was in progress to determine the public's perceptions of security at the station. Requests to the reporter by Chief Sanford D. Garelik (NYC Transit Police) and Dr. Richard F. Bloom (Dunlap and Associates, Inc.) on April 27, to delay the story for about 2 weeks while baseline data continue to be received via returned questionnaires, were not followed. Despite that revelation in the public press, we followed through with previous plans to stimulate more questionnaire responses by the use of random telephone calls and selected additional mailings of the questionnaire. However, all questionnaires received after the appearance of that news story were marked for separate analysis to establish homogeneity with the earlier responses before pooling them all.

The month of May saw the end of the pre-test questionnaire survey and the May 15 installation of the CCTV/Audio countermeasures equipment in the Rockaway Park station. On May 18, a formal ceremony to introduce the crime countermeasures system was held at the station with representatives of the NYC Transit Police, TSC, UMTA, Dunlap and Associates, Inc., GBC Closed Circuit TV Corporation and the news media. In June, the post-test survey questionnaires were mailed to residents in the experimental and control neighborhoods. Although this did not allow very much time for respondents to experience the presence of the CCTV/Audio countermeasures system, the post-test schedule was dictated by the remaining schedule of the total study.

3. RESULTS

A. General

All activities related to this countermeasures experiment were carried out according to plan, except for the delayed startup date which was governed by the OMB approval of the survey. Unfortunately, the completion date of the experiment could not be postponed past June because: (1) rider characteristics shift in the summer (especially after school ends), since the experimental station is in a beach and recreation area used by residents from many different parts of the city, and (2) reports and results of the experiment were deliverable on contractually fixed schedules in the summer and early fall. Consequently, we did not expect to find significant effects attributable to the countermeasures installation. It is hoped that later data collection will allow such measurements to be made.

B. Descriptive Statistics

The physical installation of the CCTV and Audio equipment at Beach 116th Street (Rockaway Park), Queens is seen in Figures 4, 5 and 6. Cameras and speaker-microphone units are seen mounted in the waiting room, ramp and platform areas. Physical security of those devices appeared to be satisfactory, especially since every device was visible on at least one TV monitor. The control and monitoring equipment in the District office is convenient for efficient interfacing with the Desk Officer. To that officer's right is the special log book used to record incidents associated with this countermeasures experiment.

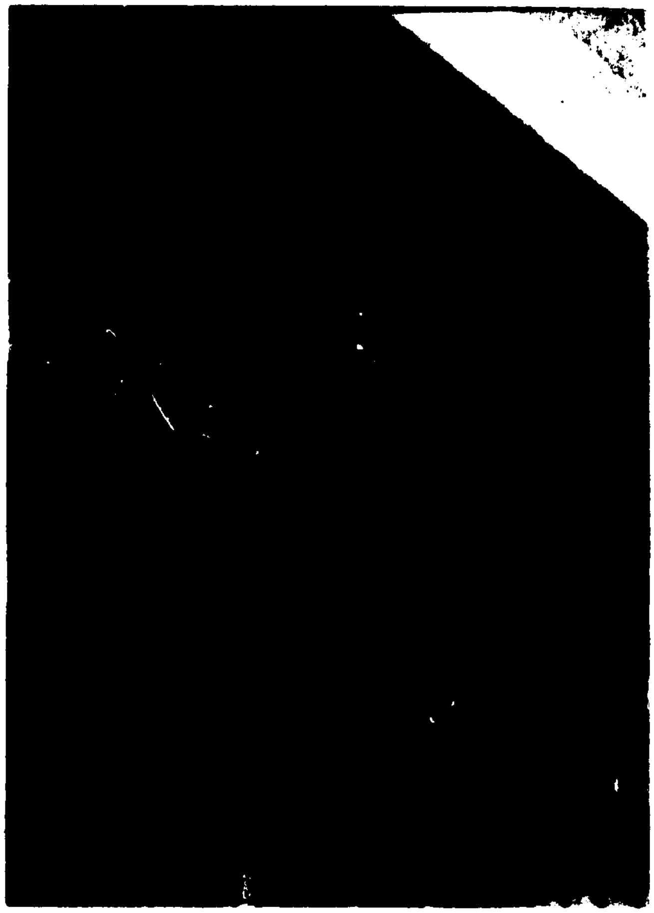
Station Statistics--Figures 7 and 8 show daily passenger entries at the experimental and control stations in 1977 and 1978, and also before and after installation of the countermeasures equipment. These ridership statistics were not expected to reflect the effects of installing the countermeasures system, especially since the system had been in operation for only about two months so far. Furthermore, the concurrent increase in summer beach passengers at the experimental station appears to have produced an immediate increase of around 70% during that same brief interval. Although that increase appears to have been only about 60-65% in 1977, we have no basis for attributing the difference to the countermeasures installation. Tables 3 and 4 show the hourly rates of entering passengers at the two stations. The NYCTA takes these hourly readings on only two days per year. In 1977 those days were March 9 and October 12. On 1978, so far, the only readings were taken on March 15--well before the installation of our countermeasure system at Beach 116th Street.

MAIN ENTRANCE

NORTH WALL

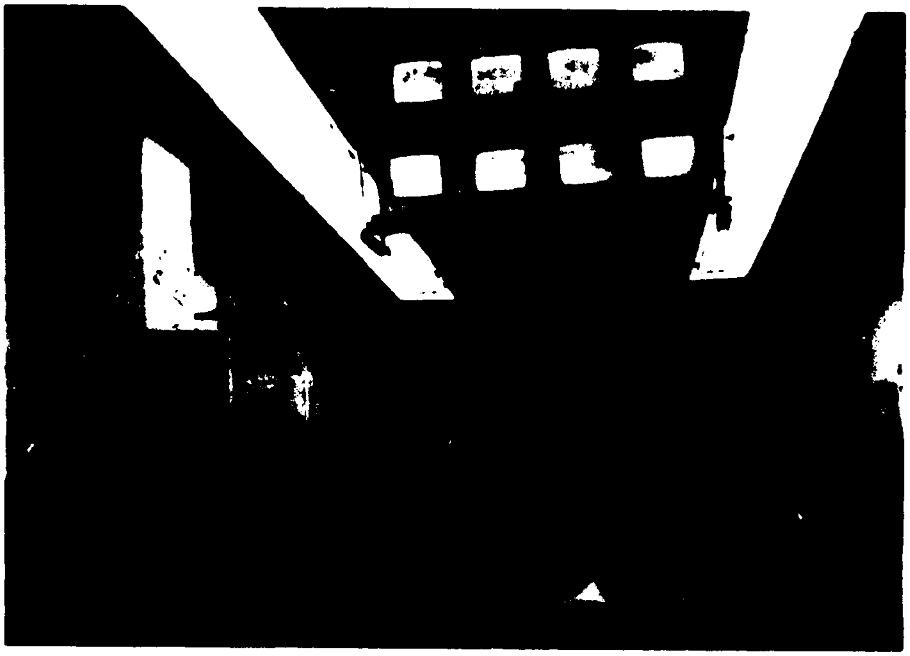
FIGURE B-4. WAITING ROOM CAMERAS/SPEAKERS

PLATFORM

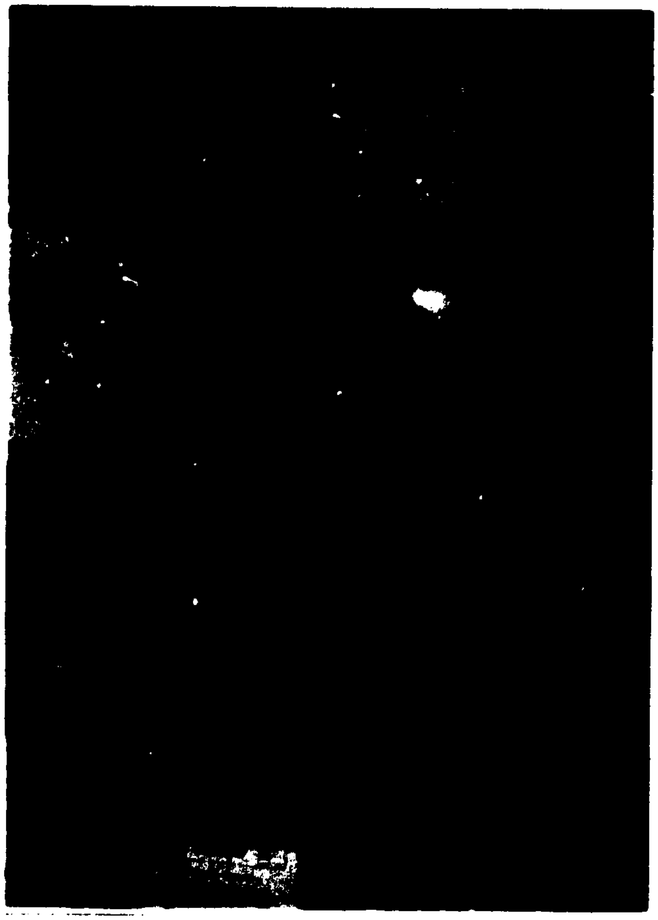


RAMP

FIGURE B-5. RAMP AND PLATFORM CAMERAS/SPEAKERS



DESK OFFICER AND MONITORS



MONITORS AND CONTROLS

FIGURE B-6. TRANSIT POLICE OFFICE

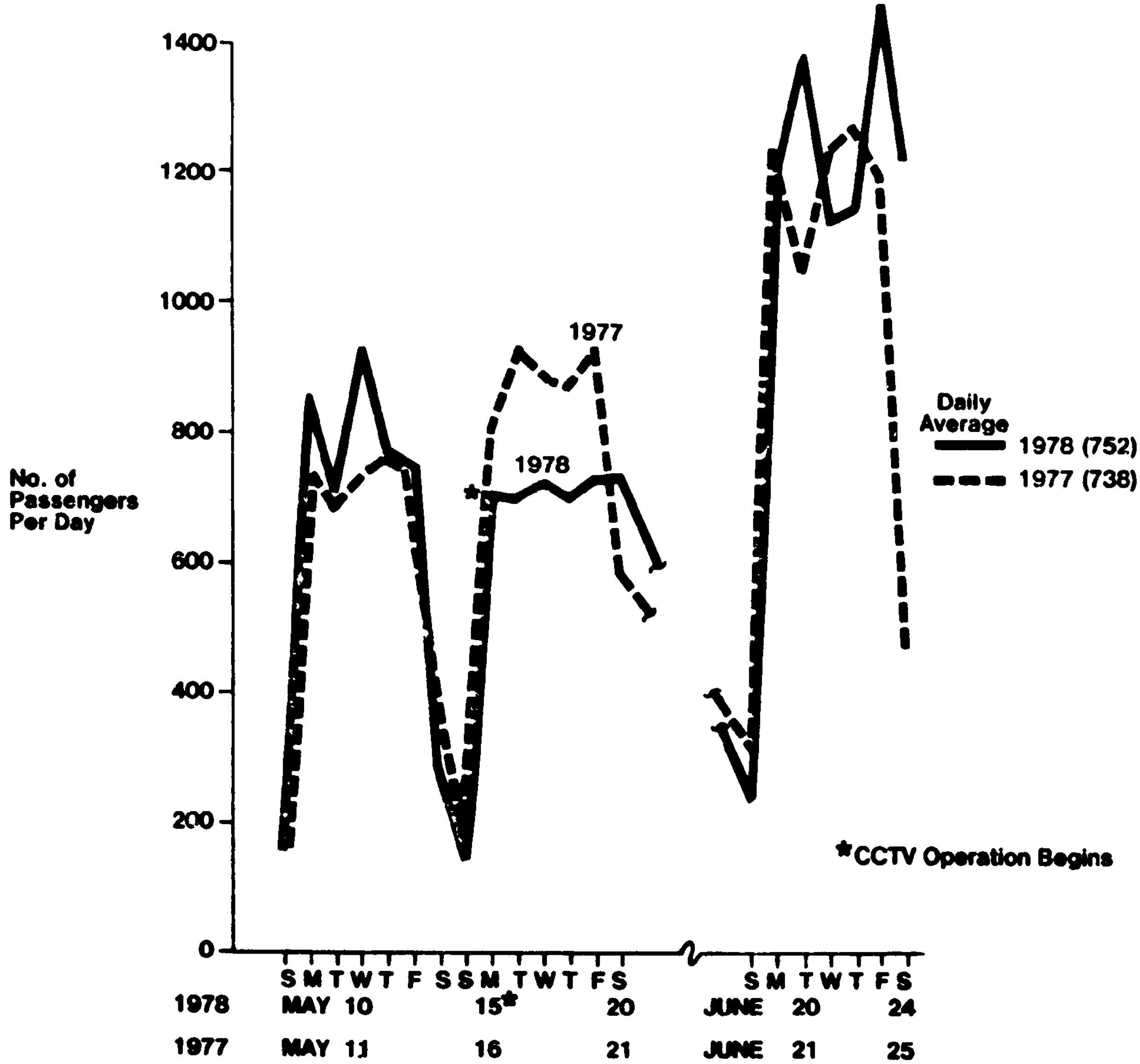


FIGURE B- 7. DAILY PAYING PASSENGERS: BEACH 116TH STREET STATION

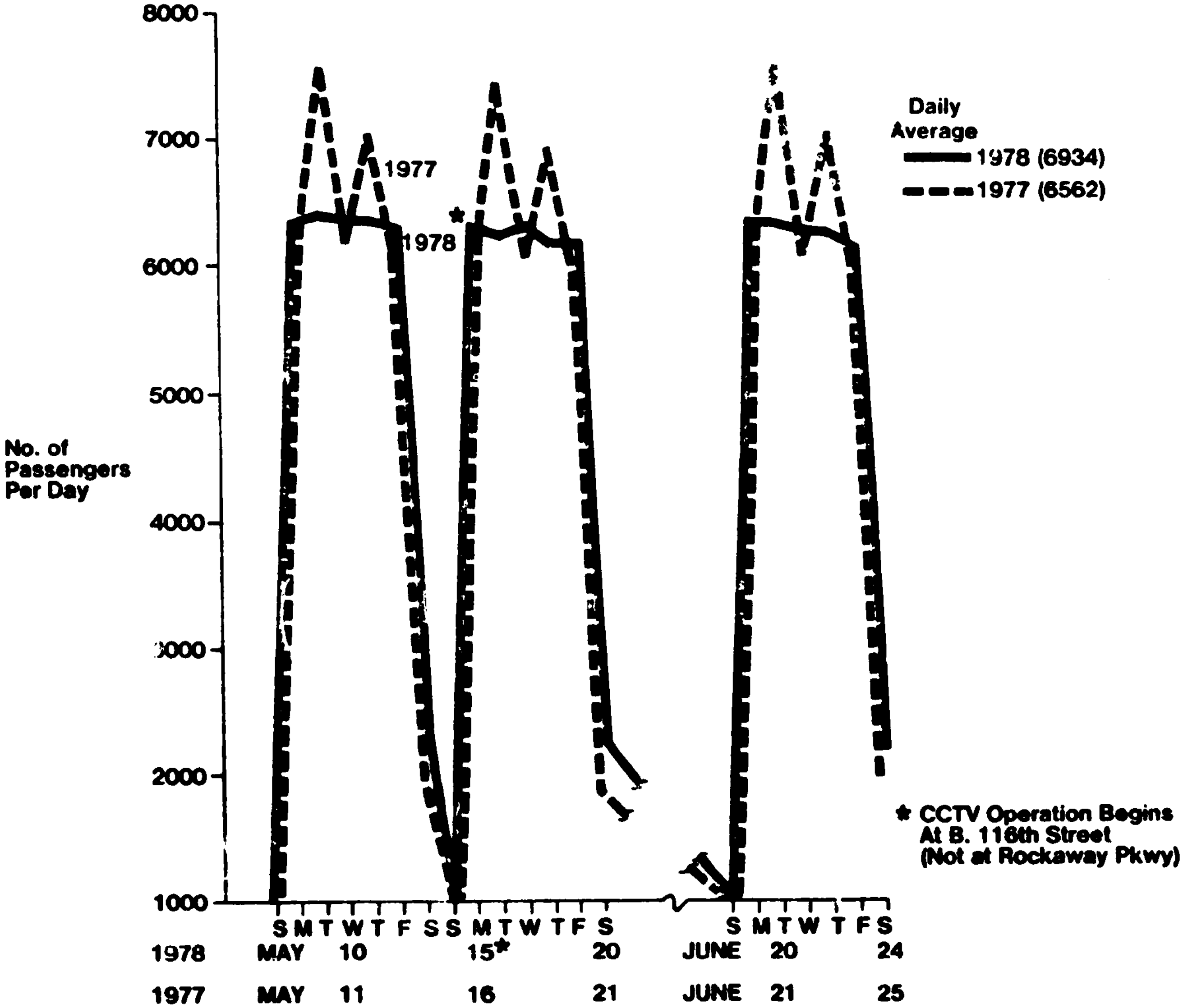


FIGURE B-8. DAILY PAYING PASSENGERS: ROCKAWAY PARKWAY STATION

TABLE B-3. BEACH 116TH STREET (EXPERIMENTAL STATION) HOURLY PASSENGER ENTRIES

For the Hour Ending	Number of Fare-Paying Passengers		
	March 9, 1977	October 12, 1977	March 15, 1978
1 a.m.	17	3	2
2	2	1	1
3	3	0	3
4	1	1	2
5	3	5	3
6	46	29	31
7	61	72	182
8	86	295	219
9	238	80	102
10	120	20	28
11	10	9	11
12 noon	11	9	15
1 p.m.	29	35	12
2	28	33	30
3	22	42	20
4	15	30	30
5	33	27	20
6	23	21	14
7	9	3	13
8	8	5	7
9	4	4	8
10	8	5	3
11	2	3	5
12 MID-NIGHT	1	0	5
TOTAL	779 fares	732 fares	766 fares

DAILY AVERAGES
1977: 738
1978 (Through July 1): 752

TABLE B-4. ROCKAWAY PARKWAY (CONTROL STATION) HOURLY PASSENGER ENTRIES

For the Hour Ending	Number of Fare-Paying Passengers		
	March 9, 1977	October 12, 1977	March 15, 1978
1 a.m.	9	17	23
2	8	6	5
3	8	5	3
4	14	10	17
5	19	34	47
6	156	148	158
7	1163	1144	1488
8	2615	1057	1351
9	730	1581	1542
10	258	639	349
11	151	308	183
12 noon	109	198	94
1 p.m.	189	236	359
2	87	67	167
3	174	153	103
4	161	120	131
5	214	150	265
6	159	218	153
7	29	70	92
8	77	40	34
9	31	24	31
10	37	42	44
11	49	43	15
12 MID-NIGHT	31	23	5
TOTAL	6478 Fares	6333 Fares	6659 Fares

DAILY AVERAGES

1977: 6562

1978 (through July 1): 6934

Consequently, these data are provided for reference purposes only, and could be used at a later date (after the October 1978 readings) to see if there have been any changes in hourly patterns following the countermeasures installation. A review of the ridership data specifically does not lend itself to any impressive inferences demonstrating the effectiveness of the countermeasures installation at Beach 116th Street.

Police Incidents--The record of complaints and arrests at the Beach 116th Street Station are minimal. According to the computer-based statistics for the station for the year 1978 (through mid July), there were a total of two arrests (for weapons possession and for assaulting a patrolman) and one complaint without arrest (for criminal mischief). This compares readily with the statistics for all of 1977, which included 7 arrests and 2 complaints. Typically, the offenses there tend to be relatively minor, such as trespassing, farebeating, larceny, obstructing justice and resisting arrest, plus those stated earlier (for 1978). At the control site, where ridership is an order of magnitude greater than at the experimental site, the 1977 statistics include 65 arrests and 11 complaints; for 1978 (through mid-July), they include 16 arrests and 9 complaints. These data are shown in Table 5.

The CCTV/Audio System log book at the District 23 Headquarters contained only five incidents in the period from system installation on May 15 to July 31, 1978. Those are summarized in Table 6. Clearly, these incidents reflect the low level of serious crimes at the Beach 116th Street Station. However, they also reflect the important role played by the audio monitoring subsystem in the incident detection and response phases.

Equipment Performance--The CCTV/Audio equipment functioned satisfactorily. A minimal number of technical problems arose, and they were corrected by the supplier (GBC Closed Circuit TV Corporation) in reasonable time. The malfunctions included:

- Video Tape Recorder; 6/3/78; not winding properly; repair time: about 1 week

- Video Tape Recorder; 6/14/78; creating picture distortion (ripping); repair time: 2 days

- TV Monitor No. 5; 7/6/78; no picture; repair time: same day

In addition, one of the ten tape cassettes was found to be faulty and was returned for repair.

TABLE B-5. NYCTA COMPUTER FILE OF ARRESTS AND COMPLAINTS

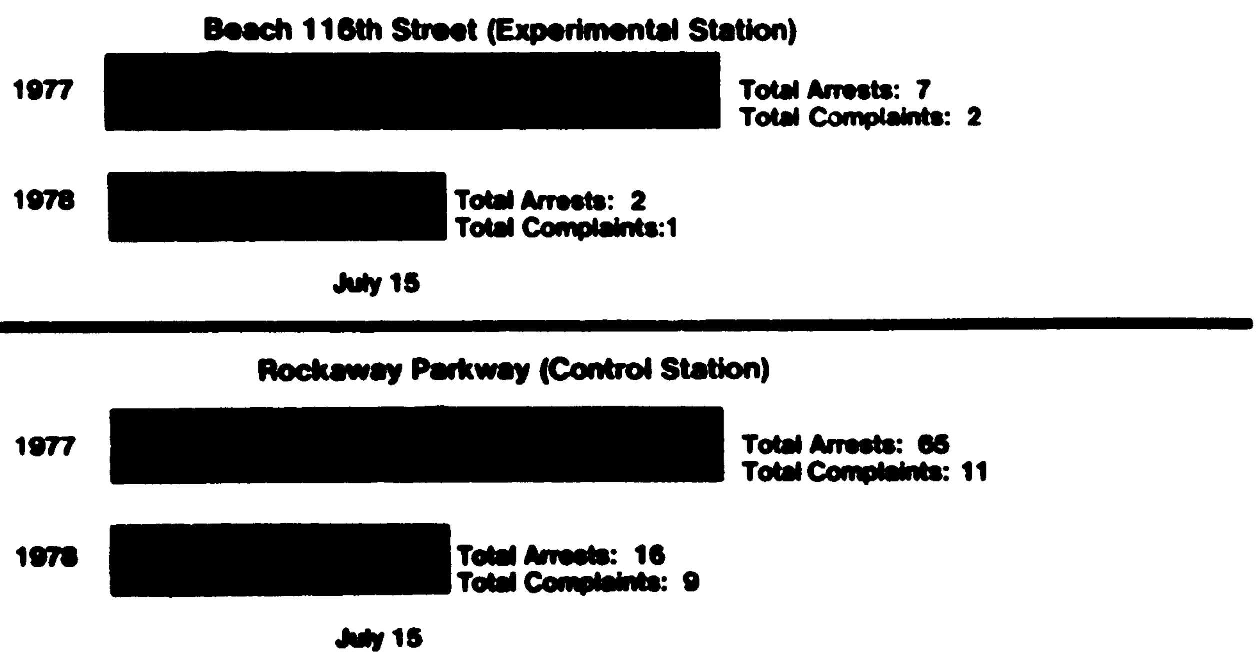


TABLE B-6. POLICE INCIDENTS INVOLVING CCTV/AUDIO SYSTEM AT BEACH 116TH STREET STATION

CONDITION	DATE	TIME (hrs)	DETAILS
Loitering	05/18/78	1738	Loitering by an apparent derelict; ejected via audio command
Disorderly Conduct	05/22/78	1623	Youth on skateboard; warned and admonished via audio command
Smoking	05/27/78	0656	Smoker observed; summons issued
Truancy	06/06/78	1100	Nine year old youth observed on platform; turned over to school authorities
Harassment	06/11/78	1800	Disturbance heard on platform; one male harassing another; summons issued

C. Subjective Reports

The main set of comments in response to this countermeasures system was provided by the NYC Transit Police at District 23 Headquarters. They noted the importance of the audio monitoring capacity as a means of detecting incidents in the Beach 116th Street Station. When the audio command is effective, it saves the need for a physical response by the Desk Officer or his aide. The officers at District 23 Headquarters seemed to be satisfied with the equipment performance. The TV monitors were easy to see and, in fact, were described as "compelling" in their ability to draw the attention of the Desk Officer from time to time. The satisfactory performance and servicing of the system was confirmed by Detective Jacobs of Chief Garelik's office at the transit police central headquarters.

A few passenger comments about the system appeared on some of the post-test questionnaires. A small number of respondents attributed changes in their perceived level of security to the presence of the CCTV monitoring system during this brief experimental period.

Comments by the equipment supplier, GBC Closed Circuit TV Corporation, echoed the others in terms of satisfactory equipment performance and maintenance. No special problems were noted with the present system, although ideas for improving it and other future systems were offered. Those ideas are included in the next section (Discussion).

4. DISCUSSION

The experimental period was shorter than originally planned, and did not allow time for some effects to develop sufficiently for measurement. However, various lessons were learned and indications of potential longer-term effects are evident. Described below are some resulting ideas which may lead to improved system effectiveness at lower system cost.

In terms of selecting a CCTV/Audio System for the crime countermeasure, one appeals to the passengers' improved perceptions of security which come from feeling that they are being watched and listened to by an individual interested in their well-being. We were aware of no passengers that had a negative reaction (e.g., "invasion of privacy") to being so observed. This device also appealed to the transit police, giving them an extension of their ability to detect incidents and to respond without having to be "everyplace at once." The system appealed to the designers because it provided more "eyes and ears" without significantly increasing the number of transit system personnel required, and it did so in a reliable way because the equipment was reliable.

In retrospect, it is found that some cost savings were achieved, and others could possibly have been achieved. For example, although the light levels at some station locations were marginally low (in the order of 10 foot-candles), we still chose to use the conventional vidicon cameras (GBC Model CTC-3010) rather than the more expensive (by about $650) and more sensitive (about 10 times) low light cameras with automatic iris controls (GBC Model TD-3410). This turned out to be a good decision, for visibility was generally satisfactory in all areas at all times of day or night. If an area would have been found to be too dark, we were prepared to increase the artificial light level rather than use the low light cameras. The CCTV equipment supplier noted that even more cost savings could have been achieved by relaxing the requirement for certain out-of-reach cable runs being enclosed in rigid conduit, when exposed wire would have been just as secure and reliable.

If more money were available to improve effectiveness, a better quality audio system with higher frequency response could have been selected, in order to increase the sensitivity to higher pitch sounds such as found in some people's (especially women's) voices. Some thought could be given to using one video tape recorder for each camera rather than time-sharing one recorder among all cameras via the automatic sequential switches used here. Though expensive, such a design improvement could mean the difference between capturing or missing the recording of an incident, especially if operating in the time lapse mode rather than in the real time mode. Transit police found it to be a disadvantage to have that time mode control out of reach. The video tape recorder used here had no remote control capability, and because of space limitations was located in a back room about 20 feet behind the Desk Officer. Normally running in time lapse mode, the recorder was not usually switched to real time when an incident occurred because the Desk Officer would prefer to run out to the incident immediately and directly rather than detour to the recorder for the purpose of switching time modes.

The Transit Police also see an advantage to using color TV because it helps in getting a good identification and description of perpetrators (especially their clothing). Since many arrests are made as a result of area searches following an incident, officers would be greatly aided by the information available on a color TV monitor.

Greater flexibility of camera locations and aiming were also goals expressed by the local Transit Police. For example, they want to have a greater voice in selecting initial camera locations, to be able to change camera locations as they gain experience with the setup or as conditions change, to be able to scan areas by panning of cameras, and to be able to get enlarged views of selected areas or individuals by means of zoom lenses.

APPENDIX C

Report of New Technology

The work performed under this contract has provided two models of perceived security. One model describes the determinants of perceived security, the other the role of perceived security in transit system use.

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110 copies