REDUCING CRIME IN APARTMENT DWELLINGS: A METHODOLOGY FOR COMPARING SECURITY ALTERNATIVES

Michael I. Liechenstein

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ABSTRACT

Presented are a portion of the methodology and an overview of a study, sponsored by Mayor Lindsay's Criminal Justice Coordinating Council, which examined techniques for improving security in New York City Housing Authority buildings. Except for an expanded and updated reference list, this paper is essentially that presented at the 37th National Meeting of ORSA, Washington, D.C., April 20-22, 1970.

PREFACE

This research, done under the auspices of Mayor Lindsay's Criminal Justice Coordinating Council, examined techniques for improving security in New York City Housing Authority buildings.[1] The crime patterns in the housing projects were analyzed first to determine the major threats against security. Next, a theoretical analysis was undertaken to develop criteria for judging the effectiveness and operational suitability of arbitrary security systems. This served as a basis for grading the effectiveness of fifteen security alternatives that were synthesized from knowledge gained on criminality, security technology, and characteristics of the protected environment. These performance scores were finally coupled with cost estimates to ascertain the most cost-effective candidates for possible implementation.

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Michael I. Liechenstein*

The New York City-Rand Institute

I. INTRODUCTION

The large and increasing volume of reported crime in our cities -- particularly in neighborhoods having low-income housing -- are features of recent history documented by the statistics of numerous police departments. These growing threats to personal safety and property are reflected as well in the heightened fears of victimization on the parts of many city dwellers. This and the increasing reluctance to walk freely in our city streets demand remedies to substantially reduce, if not eradicate, the mounting hazards attributable to crime.

A complete solution to this serious problem awaits fundamental social changes. Unfortunately, much research to date, as well as official action, has focused on the symptoms of crime rather than on its criminogenic mechanisms. Many treatment programs have failed miserably as their originators did not appropriately take into account the symptomatic nature of crime, nor its association with a problem that transcends crime itself -- poverty.

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This paper was presented at the 37th National Meeting of the Operations Research Society of America, Washington, D.C., April 20-22, 1970.

Despite the fact that technology alone cannot be an effective long-term substitute for measures which deal with human behavior and the design of cities, numerous agencies have begun seeking improvements via several complementary courses of action. By systematically applying existing technology, by influencing the development of advanced technologies, by educating the community on simple preventive measures, by inculcating or enforcing community responsibility for security, and by instituting more efficient and effective procedures throughout the criminal justice system, agencies are endeavoring to ameliorate crime conditions.

The remaining discussion describes one of several methodologies that were recently developed to help in identifying cost-effective security alternatives for reducing crime in the New York City Housing Authority projects. Because of uncertainties about crime characteristics, the extent to which causative factors influence crime, and the way in which criminals and security systems interact, we adopted an approach which permitted both objective and subjective data to be blended into an heuristic scheme for ranking different security options. The study, sponsored by Mayor Lindsay's Criminal Justice Coordinating Council, indicated that robbery, and especially robbery in elevators, ought to be the primary concern of a security improvement program.[*] Because of the large incidence of burglaries -- committed primarily by unskilled burglars -- and because of the strong possibility that this crime could be reduced via tenant education and new, low-cost building hardware, burglary became the secondary focus of the study.

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[*] See Ref. (1).

II. SECURITY SYSTEM CONCEPTS

Contemporary security system design lacks a methodology for identifying promising crime countermeasures. The problem is complicated not only by the diversity of crime types, offender methods, victim characteristics and conditions under which crimes occur, but also by the profusion and inconsistency of opinions offered about what remedies are "best" in each circumstance. Such complexity demands, but has seldom received, a systematic approach -- one which defines goals, identifies functions to be accomplished, and translates those functions into detailed system requirements and specifications for component performance.

In the following discussion we will develop guidelines for estimating the cost-effectiveness of arbitrary security configurations. We will use the term "security system" to denote an entity which interacts under external constraints with specific threats and protective elements to accomplish criminal deterrence and apprehension. "Threat domain" will denote the specific criminal activities to be curtailed by the security system; the description will include such factors as forcefulness, frequency, scale, modus operandi, etc., and their translation into physical characteristics. "Protective domain" will signify the specific property and persons to be safeguarded as well as the precise locations and times involved. Finally, the "constraint set" will include the technical descriptors of the relevant social, political, economic, technical, environmental, etc., factors that circumscribe the threats, the protected personnel and property, and the security system itself (i.e., where such technical representations are possible).

This definition leads to a broad operational view of a security system and includes the notions of security held by several agencies. The property owner, for example, considers a security system as a conglomeration of components which jointly act to reduce personal loss. The police would add the notion that a security system should enable the apprehension of offenders. An insurance underwriter would view a security system in terms of its ability to facilitate recovery of stolen goods; an attorney, in terms of providing evidence for convictions; a social worker, in terms of deterring or denying antisocial behavior, etc. However, one can attempt to state broadly what a security system is in a way which considers all these viewpoints.

Basically, the measure of effectiveness for a security system should be the degree to which thoughts of crime are not translated into actual deeds, and, failing this, the extent to which attempted crime is not successful. To be effective, a security system must act as a deterrent, provide resistance, and give an apprehension capability. Two strategies are commonly employed to deter or resist criminal acts and to make them self-defeating:

- Decreasing the real or apparent opportunities for crime
- Increasing the perceived risk of apprehension and penalty

Since these deterrents and denials do not always suffice, an ability to apprehend and penalize must be actually present, generally in the form of the following actions:

- Detect and discriminate the crime
- Actuate and transmit an alarm condition
- Annunciate and decode the alarm
- Command and control forces
- Transport forces to the crime area
- Search and examine the crime area
- Identify, locate, and arrest the criminal
- Provide evidence to aid in conviction
- Recover property

Security effectiveness is reflected in the successful, collective accomplishment of these tasks. In order to apply numerical or judgmental ratings to alternative security proposals, however, these operational elements must be translated into effectiveness criteria. The measures of effectiveness can then be coupled to compatibility and cost criteria to derive estimates of an overall figure of merit (e.g., the ratio of effectiveness-to-cost with a constraint on either minimum effectiveness or maximum cost).

The following list, though not exhaustive, will suffice to evaluate most aspects of security design commonly of interest. As will become apparent in the definitions which follow, the proposed security criteria are interdependent and the numerical assignments or rankings which can be ascribed to them will vary with the specific threat category, the protective domain, and the operational constraints.

We have previously described deterrence as the capacity to prevent threat initiation and to make criminal activity self-defeating. A deterrent

SECURITY EFFECTIVENESS, COMPATIBILITY AND COST CRITERIA

- Security Effectiveness Criteria

  Deterrent probability

  Detection probability (sensitivity, spatial and temporal coverage)

  Discrimination and identification capacity (false alarm/dismissal rates)

  Alarm transmissibility

  Response capacity

  Reliability (system failure rates)

  Survivability (susceptibility to destruction)

  Adaptability (accommodation to changing threats and elusive countermeasures)

- Compatibility Criteria

  Convenience of use

  Privacy incursions

  Aesthetic appeal

  Dependence on user cooperation

  Installation feasibility

  Modularity (ease of system expansion)

  Availability (for purchase and use)

  Safety

  Repairability (ease of maintenance)

- Cost-Benefit Criteria

  Research and development cost (equipment, maintenance, administration before production)

  Capital cost (equipment, maintenance, and administrative costs during production)

  Operating cost (equipment, maintenance, administration costs during use)

  Scrap value (residual value at end of use)

  Expected total benefit

capability can consist of real physical barriers as well as suggested ones. The combination of these physical and psychological obstacles should heighten the potential perpetrator's imagined and actual chances of apprehension and conviction.

By detection, we mean discovery of the existence of characteristics indicative of a threat. By this definition, detection differs from the usual connotation of entrapment, identification, or verification. Detectability is linked instead to system sensitivity and to spatial and temporal coverage.

Closely related to detectability is the capacity for discrimination, i.e., the ability to distinguish real threats (the desired signals) from innocent activity (noise) and to classify uniquely each threat signature.* Because random noise introduces uncertainty into all real security systems, an obvious tradeoff exists between these detection and discrimination functions. By accepting a sufficiently high false alarm rate, the false dismissal probability can be made arbitrarily close to zero. Thus, the level at which a detection threshold is set always results in a compromise between mistakenly announcing or ignoring an alarm. The selection of the proper threshold level depends on the importance or costs associated with the two types of errors.

The alarm process requires only intelligible annunciation, usually after transmission to a command-and-control center removed from the crime

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*It is discrimination capacity which makes the human an indispensible element of high security systems. Humans are more readily adaptable to elusive threats and are far better at real-time pattern recognition than currently available physical mechanisms.

area. The alarm can be based on detection alone, discriminated detection, or both. Once an alarm is made, the system must respond forcefully enough to abort the threat if the net gain from doing so exceeds some preassigned threshold. Since it may be necessary to do this repeatedly, the system's duty cycle must match the highest anticipated threat repetition frequency. Moreover, the system's response time must be less than the total crime duration if on-site arrest is to be made. The response mode itself might be any of a number of forms: from no action, to a simple electromechanical or chemical trap, to an elaborate security guard.

System reliability involves the assurance of meeting a prescribed confidence level for system operability. Reliability is also closely related to the requirements of repairability and maintainability, perhaps even the capacity for self-diagnosis and fault indication, if not for self-repair.

The system must also fulfill a specified probability of satisfactorily functioning in the face of numerous countermeasures: sabotage, vandalism, unintentional and purposeful jamming, etc. This is what is meant by survivability. We distinguish this from adaptability, the ability of the system to cope with changing or elusive threats for which it was not specifically designed.

When these criteria are further coupled with compatibility and cost criteria, it is possible to relate the total performance effectiveness of the security system to the total benefits of implementation. The latter quantity may be exceedingly difficult to estimate since it demands not only the costing of the resources reallocated to the security system's physical components, their assembly, installation, operation, and maintenance, but also of the economic benefits expected from preventing crimes like burglary, robbery, assault, rape, homicide, etc. The problem is further complicated when inconvenience, loss in privacy, aesthetic conflict, the saving of lives, etc., must also be considered.

III. A RANKING SCHEME FOR ALTERNATIVE SECURITY SYSTEMS

Relating these proposed operational criteria to detailed technical specifications is a difficult task. Because of imperfect knowledge of threat characteristics, causality, and the extent to which causative factors influence crime output, we cannot rely solely on objective analysis to allocate resources among security alternatives. These uncertainties, coupled with the complex policy questions which often come into play, the inability to estimate accurately the costs of different proposals, and the difficulty in assessing the benefits of implementation, force us to blend authoritative opinions, experiential judgements, and other subjective evaluations with the facts derived from the analytically tractable portions of the security problem.

The following approach allows us to organize objective and subjective information into a ranking scheme for security alternatives.* The method is useful when deficiencies in objective data make subjective estimates necessary, as is the case in security and crime analysis. The procedure, in addition to being a heuristic analytical tool, can be used to give a trial-and-error synthesis capability. By iterating designs, we can devise security plans that are better matched to protective needs and to the existing environmental, social and other constraints (which may vary significantly among projects, or even among buildings within a project). In so doing, however, we will have to anticipate any induced crime displacements ("spill-overs") or escalation effects ("crime switches") and reconcile them with

*Other evaluative schemes are described in Appendix D of Ref. (1) and in Refs. (2) through (4).

the expected short- and long-term benefits of implementation.

The effectiveness ranking scheme comprises four steps:

(1) Description of the Threat Domain -- Security Goals

First a list of the threats or crime categories which are to be treated is specified. Associated with each crime type C_i is a rating c_i which reflects the relative importance of crime C_i with respect to the total N crime types considered.* The values assigned to the c_i will depend on both available crime statistics for all N crime types and the judgments about the magnitude of disbenefit incurred by each and all N crime types.(5) The value given to c_i will be its percentage of the total, so that the sum of the c_i is always 100, thus,**

$$\sum_{i=1}^{N} c_i = 100 \qquad N = \text{Number of crime categories} \tag{1}$$

(2) Threat-Vulnerability Analysis

Next, an examination of the vulnerabilities in the existing (baseline) security system is made, employing the security criteria discussed earlier. From these vulnerabilities an enumeration of desirable security features, F_{ij}, is made for each crime type, C_i. For the i^{th} crime type, the total

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*As an illustration, C_1 might be burglary; C_2, elevator robbery; C_3, hallway robbery; etc. If only these three crime types were to be countered, N would be equal to three.

**For example, c_1 might be 50 (percent) for burglary; c_2=40 (percent) for elevator robbery; c_3=10 (percent) for hallway robbery; etc.

number of desired security characteristics is denoted by M_i.* As before, we assign a weight or relative importance rating f_{ij} to each F_{ij}. Thus, f_{ij} is the percentage impact which factor F_{ij} contributes to the total resistance to crime type C_i. For any particular crime category, the M_i weights f_{ij} will always add up to 100; i.e.,

$$\sum_{j=1}^{M_i} f_{ij} = 100 \qquad i = 1, 2, \ldots, N \tag{2}$$

(3) Effectiveness Analysis

Third, each considered security alternative or crime remedy is listed and denoted by A_k, where k is an index running from 1 to P, the total number of candidate alternatives.** To each of these alternatives is associated a figure of merit, r_{ijk}, which indicates on some arbitrary scale the estimated efficacy of the k^{th} remedy in providing the j^{th} security countermeasure to the i^{th} crime type. The numbers given to the r_{ijk} can be drawn from an arbitrary scale of -R to R, the negative numbers reflecting the fact that a security measure that is productive in one context may be counterproductive in another.*** The security criteria presented earlier can provide a useful guideline for making the numerical assignments, especially

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*For example, for i = 1, burglary, F_{11} might be apartment ingress limitation; F_{12}, increased lighting and crime visibility, etc.; for i = 2, elevator robbery, F_{21} might be building ingress limitation; F_{22}, increased elevator cab visibility; etc.

**A_1 might be a telephone interviewer with remotely actuated lobby door locks; A_2 might be door locks and chains on individual apartment doors; A_3, express elevators from the lobby to the tenant's floor, key controlled buttons, and transparent doors; etc.

***Thus, if R were chosen as 10, the scale would go from +10 to -10, with 10 indicating excellent; 6 good; 3 fair, 0, no change or effect over when coupled with data on benefits and effectiveness drawn from experiences with similar crimes and security systems.

(4) Performance Ratings

Using this scheme, which is summarized in the accompanying chart, we can compute several performance scores:

$$T_{ik} = c_i \sum_{j=1}^{M_i} r_{ijk} f_{ij} \tag{3}$$

the performance subtotal for the k^{th} security alternative A_k operating against the i^{th} crime type C_i; and

$$T_k = \frac{1}{100 \cdot R} \sum_{i=1}^{N} T_{ik} = \frac{1}{100 \cdot R} \sum_{i=1}^{N} \sum_{j=1}^{M_i} r_{ijk} c_i f_{ij} \tag{4}$$

the normalized total performance of the k^{th} security alternative A_k against all N crime types C_i.* Utilizing the same scoring units, we can compute a compatibility score by adding together the individual assignments made to each of the compatibility criteria listed before. If the relative importance of compatibility and performance is known, the compatibility scores and performance totals of the security alternatives can then be correspondingly weighted and summed, and cost-effectiveness ratios can be

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the baseline system; -3, detrimental; -6, even more harmful; and -10, most damaging. If ratings fall between these categories an expanded scale might be considered.

*The factor $1/(100 \cdot R)$ normalizes T_k to the interval (-100,100), independent of scale choice R. Thus, the best security alternatives have scores of 100; the worst, -100,

PERFORMANCE RATING SCHEME FOR SECURITY ALTERNATIVES

Crime Types	Rating Percent	Desired Security Characteristics	Rating Percent	Security Alternatives and Ratings			
				A_1	A_2	...	A_p
C_1	c_1	F_{11}	f_{11}	r_{111}	r_{112}	...	r_{11P}
		F_{12}	f_{12}	r_{121}	r_{122}	...	r_{12P}
		⋮	⋮	⋮	⋮		⋮
		F_{1M_1}	f_{1M_1}	$r_{1M_1 1}$	$r_{1M_1 2}$	...	$r_{1M_1 P}$
C_2	c_2	F_{21}	f_{21}	r_{211}	r_{212}	...	r_{21P}
		F_{22}	f_{22}	r_{221}	r_{222}		r_{22P}
		⋮	⋮	⋮	⋮		⋮
		F_{2M_2}	f_{2M_2}	$r_{2M_2 1}$	$r_{2M_2 2}$	...	$r_{2M_2 P}$
⋮	⋮	⋮	⋮	⋮	⋮		⋮
C_N	c_N	F_{N1}	f_{N1}	r_{N11}	r_{N12}	...	r_{N1P}
		F_{N2}	f_{N2}	r_{N21}	r_{N22}		r_{N2P}
		⋮	⋮	⋮	⋮		⋮
		F_{NM_N}	f_{NM_N}	$r_{NM_N 1}$	$r_{NM_N 2}$	...	$r_{NM_N P}$

computed.* If the relative weights are not exactly known, a sensitivity analysis can be made. The alternatives with the highest grand totals may finally be picked as the most promising and/or selected for further scrutiny. If the latter course is elected, a "Delphi-like" procedure can be employed to iteratively refine the values ascribed to the c_i, the f_{ij}, and the r_{ijk}.[6] Where consensus does not occur, experiments can be designed and run to resolve ambiguities or to yield more precise data.

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*Before combining the scores, minimum acceptable performance levels should be set for each individual criterion and satisfied by each alternative. Even so, the consolidation of individual, disparate scores into one measure may be misleading (see Ref. (15), pp. 25-26) and mask the inevitable, difficult tradeoffs that must accompany final selection of alternatives.

IV. SOME ALTERNATIVES FOR REDUCING CRIME IN NYCHA APARTMENTS

Measures for enhancing the personal safety and property security of tenants have been discussed widely in the crime/security literature, including special reports on crime in the New York City Housing Authority (NYCHA) developments.[7-14] We present here an expanded list of strategies for security improvement, some of which are already being tried by the NYCHA.* The set of alternatives are broadly characterized by whether they primarily entail tenant cooperation, physical devices, or police/guard manpower. The list is not exhaustive, nor are the various approaches independent or mutually exclusive.

Because of their long-term nature, or because of the present difficulty in judging their effects, some of the potentially worthwhile measures listed were not considered in our analysis of alternatives for security improvement -- alternatives which could be implemented within one year and which could provide significant performance information in a one-year's trial. Several of these inherently long-term programs are already being tried by the NYCHA and other agencies who recognize the heavy dependence of security on community cooperative involvement and good police-community relations, as well as the important ancillary benefits which the programs may afford. Thus, we have concentrated on approaches which reduce the opportunity and rewards for criminal activity, rather than on schemes which basically affect the desire or need to perpetrate crime or to be victimized.

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*See accompanying table.

BROAD STRATEGIES FOR SECURITY IMPROVEMENT

- Tenant-Cooperative Measures

  Training and Education - (on self-defense, on the modus operandi of criminals, on preventive measures, etc.).

  Tenant Patrol - (to perform watchguard duty and other community services).

  Tenancy Qualifications - (to determine admissibility and tenure conditions).

  Property Security Code - (to reduce, by a system of inspection and citation, vulnerability to burglary, robbery, etc.).

  Extended Recreational Facilities - (to sublimate teenage activities).

  Rent Rebates and Other Positive Incentives - (to discourage vandalism, etc.).

- Security Devices

  Building Security Hardware - (locks, chains, lights, mirrors, fences, doors, screens, peep-holes, armor, intercoms, etc.).

  Physical Barriers for Ingress Limitation - (locked lobby and stairwell doors, turnstiles, key-card elevator control, etc.).

  Intrusion Detectors - (radiation, pressure, strain, chemical sensors, and transducers).

  Personal Signalling Devices - (portable transmitter to activate alarms, etc.).

  Tagging and Other Identification Aids - (to discriminate tenants, criminals, etc.).

  Weapon Detectors - (induction balance, radiation detectors, olfactronic devices, etc.).

  Decoys and Other Deception Techniques - (to aid in deterrence).

- Police/Guard Measures

  Manning Changes

  Alternative Deployments

  Operational Innovations

  Doormen and Special Attendants

  Training and Educational Programs

We also excluded from the analysis those hardware options which could not be synthesized from conventional or state of the art components and systems.

The array of alternatives which we present are graduated in effectiveness from the bell-buzzer/telephone intercom systems which offer little anticipated improvement over the baseline security system (i.e., the existing security measures of the present NYHA projects) to programs involving controlled building access, extended surveillance and monitoring of public areas, and increased police manning.* The lowest cost options are of interest in that tenants have been polled (in accordance with recent New York State legislation on building security for multiple dwellings of eight or more units) to determine their willingness to incur rent increases in support of vestibule construction, electronically locked lobby doors, and intercom system. The highest cost options which are described are more interesting as theoretical benchmarks of security effectiveness than as economically viable alternatives for security improvement. Neither the tenants of NYCHA developments (whose average rent is $70 per month per apartment) nor the NYCHA could reasonably be expected to budget for such systems.**

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*The detailed descriptions and cost analyses of the alternatives are discussed in Ref. (1). Briefly, research and development costs were zero (only off-the-shelf items were considered), and system scrap values at the end of 7-10 year life cycles were taken as zero. The component and installation costs do not reflect the substantial discounts which may result from competitive bidding or from economies in labor during installation of many conventional systems. Costs include installation, one-year's maintenance, and debt service; only incremental expenses were considered in computing manpower costs. The number of apartments per building and buildings per project were assumed to be 100 and 10, respectively.

**An expenditure by the NYCHA of $0.50 per apartment per month becomes about $1 million per year on a city-wide basis. Although a security measure may not be appropriate to all housing projects, political and social pressures may dictate city-wide implementation.

DESCRIPTION OF SECURITY ALTERNATIVES

SECURITY ALTERNATIVES AND ESTIMATED AVERAGE COST*

I INTERCOM LOCKED LOBBY APARTMENT LOCKS	II HAPD PROJECT PATROLMAN	III CATEGORY I PLUS REMOTE GUARD SURVEILLANCE	IV CATEGORY I PLUS PERSONAL & APT. ALARMS	V CATEGORY I PLUS LOBBY GUARDS/POLICE
A_1 Intercom & Locked Lobby $2.65	A_7 Add 1 HAPD Officer per Project Full-time $5.44	A_8 Intercom, Exit Alarm, Apt. Door Armor, Full-time T.V. Lobby Surveillance by Remote Guard $6.20	A_{11} A_3 Plus Personal Transmitters, Burglar Alarms, Computer Monitoring Service $9.08	A_{12} A_9 But with Guard in Lobby One Shift $12.58
A_2 Phone Call-up & Locked Lobby $2.85		A_9 A_8 Plus Apartment Alarms to Guard Station $7.06		A_{13} A_{12} With Full-time Lobby Guard, Less Apt. Alarms $25.49
A_3 A_2 Plus Exit Alarm & Apt. Door Armor $3.08		A_{10} A_9 Plus Glass Guard Booth $7.08		A_{14} A_{13} Plus Apt. Alarms $26.35
A_4 A_3 Plus Deadbolt Chainlock $3.29				A_{15} A_{13} But with Full-time HAP in Lobby, Less Apt. Alarms $57.39
A_5 A_3 Plus Highly Resistant Vertical Deadbolt Lock and Cylinder $3.34				
A_6 A_2 Plus Alarm Lock $3.94				

*Dollars per apartment per month.

In order to synthesize and judge the feasibility of specific plans for security improvement within the three mentioned categories, the Rand study group has closely collaborated with numerous agencies. Most frequently consulted were prominent security experts, members of police detective, communication and statistical bureaus (particularly within the HAPD and NYPD), manufacturers of security devices, security consultants and installers of proprietary and central station equipment, Housing Authority directors and managers of individual NYCHA developments, HAPD patrolmen and supervisors, tenant patrol organizers and representatives of tenant councils, engineers and scientists, psychiatric social workers, specialists on the legal aspects of surveillance and privacy, and, to a much lesser extent, architects and city planners. Despite the heavy interaction with these groups and an extensive survey of the security literature, only a partial, qualitative characterization was possible of the threats, constraints, protective domain, and security alternatives. The design options and cost-effectiveness estimates which follow must be understood in this context, i.e., lack of fundamental knowledge and quantitative information on the parameters governing crime and security system interactions.

In the absence of these predictors of security system effectiveness, as well as the quantitative inputs for such models, our a priori estimates of the effectiveness of the security options arrayed in the accompanying chart relied largely on subjective data. For these reasons, we utilized the heuristic scheme introduced earlier to obtain relative performance ratings. The judgements which are represented by the numerical assignments given in

ESTIMATED PERFORMANCE RATINGS FOR SECURITY ALTERNATIVES

Crime Types	Rating (percent)	Desired Security Characteristics	Rating (percent)	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	A_{11}	A_{12}	A_{13}	A_{14}	A_{15}
				Security Alternatives Ratings[a]														
1. Burglary Inside	24	1. Prevent Building Access	10	3	3	4	4	4	4	0	6	6	7	4	8	10	10	10
		2. Prevent Apartment Access	30	0	0	7	10	9	8	0	7	9	9	9	9	7	9	7
		3. Detect by Patrol or Surveillance	10	0	0	2	3	3	7	3	0	10	10	9	4	0	10	0
		4. Increase Crime Duration & Visibility	10	1	1	6	7	7	8	0	7	9	9	9	9	5	9	5
		5. Transmit Alarm Rapidly	10	0	0	1	1	1	2	0	5	8	9	8	8	9	10	9
		6. Respond Rapidly - Police/Guard	10	0	0	0	0	0	0	5	3	3	4	0	5	10	10	10
		7. Prevent Escape or Concealment	10	0	0	1	1	1	2	3	2	3	4	2	6	10	10	10
		8. Provide Identification Evidence	10	1	1	1	1	1	2	1	3	4	5	3	6	8	10	8
Subtotal Score/1000				1	1	9	11	11	12	3	11	17	18	15	18	18	23	18
2. Robbery Inside	76	1. Prevent Building Access	35	3	3	4	4	4	4	0	6	6	7	4	8	10	10	10
		2. Prevent Apartment Access	1	0	0	2	2	2	2	0	2	3	3	3	3	2	3	2
		3. Detect by Patrol or Surveillance	14	0	0	0	0	0	0	3	1	1	2	8	3	4	5	4
		4. Increase Crime Duration & Visibility	15	1	1	2	2	2	2	0	3	3	3	2	4	5	5	5
		5. Transmit Alarm Rapidly	5	0	0	1	1	1	1	0	5	5	6	8	8	9	9	9
		6. Respond Rapidly - Police/Guard	15	0	0	0	0	0	0	5	3	3	4	0	5	10	10	10
		7. Prevent Escape or Concealment	10	0	0	1	1	1	1	3	2	2	2	2	3	10	10	10
		8. Provide Identification Evidence	5	0	0	1	1	1	2	1	3	4	5	4	6	8	8	8
Subtotal Score/1000				9	9	15	15	15	15	12	29	29	35	28	43	62	63	62
Total Score/1000				10	10	23	26	25	27	14	40	46	53	43	60	80	86	80

[a]Ratings: 10 = most effective; 6 = good effectiveness; 3 = fairly effective; 0 = no improvement; -3 = detrimental; -6 = more harmful, and -10 = damaging.

the table are reflections of the average opinions and operational data derived from several security authorities and agencies. The ratings could be further refined by a more carefully organized polling of authority to achieve performance concensus (e.g., by utilizing procedures like the "Delphi" method).

When these effectiveness scores are combined with the cost estimates given earlier, we can compute the ratios of effectiveness to cost for each security alternative. The results of this calculation are depicted in the following graph, where the joint average effectiveness ratings for both burglary and robbery are represented.* As the graph shows, the performance-to-cost ratios range from about 0 to 8, whereas the security system cost and effectiveness estimates individually vary by more than one order of magnitude. Once a cost constraint is imposed, the alternative A_k^* having the highest performance-to-cost ratio, $T_k^* / \$^*$, can be found (satisfying, of course, the constraints imposed on the individual performance ratings, e.g., $r_{ijk}^*>0$).

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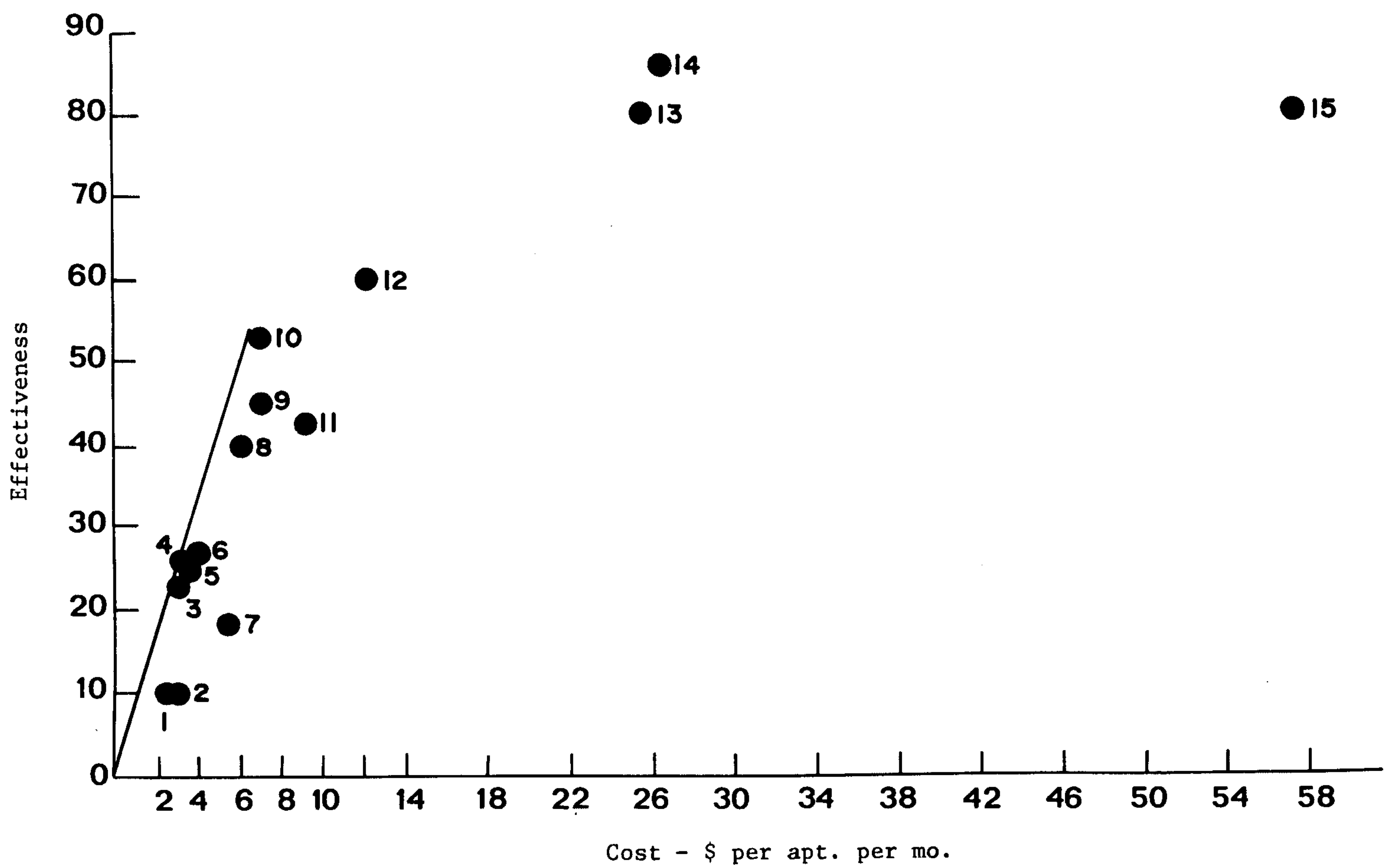
*A security measure, although specifically designed to diminish one kind of criminal activity, may have benefits in improving other crime conditions. Thus, joint performance measures may be useful in choosing among alternatives having equal effectiveness/cost ratios for one crime, but not for several.

AVERAGE EFFECTIVENESS/COST RATIOS OF SECURITY OPTIONS



V. CONCLUSION

We have explored a number of options for improving security in public housing developments, the majority of which still depend heavily on tenant cooperation for their success. The most promising of these have proven expensive, both in a monetary sense and in the anticipated sacrifices on convenience and privacy to the housing residents. The elaborate entry restrictions and the extensive surveillance typifying the higher performance security systems make them both irritating and costly as protective measures. Thus, while concerned tenant groups have called for the posting of armed guards at each building, few people would find the concomitant resemblance to an armed camp a satisfactory solution to the mounting incidence in crime.

The heuristic methodology that we have presented here is further testimony to the paucity of formalized design procedures for translating security goals into detailed system requirements. The present crime situation has created an undeniable demand for quantitative models which can account for behavioral and sociological phenomena which can adequately predict the impact of security measures on society, and which can clarify our presently fuzzy notions of what security really means.

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Liechenstein

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P-4656