COUNTER-TERRORISM: PROTECTION RESOURCES ALLOCATION

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PART III. FICTIONAL "CASE STUDY"

ABSTARCT. This paper is continuation of [*Ushakov*, 2006a; *Ushakov*, 2006b]. Here a demonstration of the methodology is demonstrated on a fictional case study.

1. SOME PRELIMINARY COMMENTS

Below is presented a simple demonstration of the method considered in [*Ushakov*, 2006a; *Ushakov*, 2006b]. All notations and terminology were given and explained in the previous papers.

Before considering the fictional case study, let us once more briefly characterize the proposed model.

This mathematical model can be used for design of an interactive computer model, which can be used by counter-terrorism decision-makers to solve the following problems:

- What are the priorities of the subjects of protection?
- What measures are most appropriate to protect these subjects?
- What is the best money allocation for this protection?

Notice from the very beginning that we are going to design a model for analysis the entire problem as a unique and single "body".

A decision-maker will be able to "play" with the model, change parameters and limitations and get current results. In other words, it will be a "WHAT IF" type of a model.

Suggested procedure of use of the model

Expert enters the following input data into the model:
- list of assumed objects of terrorists' attacks,
- priority of defended objects,
- estimated cost of various defending measures,
- estimated effectiveness of the protection of listed subjects,
- limitation on the resources assigned for the protection program.

The model will present an output (solution) in the form of resources allocation between various measures of protection and between the chosen subjects of defense.

Input data

- *List of subjects of protection.*
- *Categorization of the subjects of protection: human lives (like stadiums, conventions, etc.), economical, political, historical/symbolical.*
- *Expert-prepared relative priorities of these subjects (in scale from 1 to 10, for instance).*
- *Assumed enemy's priorities of destruction of the same subjects.*
- *Total resources for anti-terrorists' activity on the country level and on regional levels.*
- *Categorization of types of possible terrorists' attacks for each subject of protection.*
- *Expert's evaluation of the "degree of assurance" that the given subject of protection would be saved if some specified measures would have been undertaken.*
- *Cost of reliable information about terrorists plans, their location, forms of their support, etc.*
- *Experts' evaluation of the effectiveness of the pre-emptive anti-terrorists strikes depending on the expenses.*

Of course, the number of listed types of input information should be corrected (as well as the model itself) during real implementation.

Expected results of the modeling

The computer tool will allow a decision-maker to estimate numerically the effect of counter-terrorism measures and will help making optimal (рациoнал) allocation of the available resources.

The model will give the decision-maker a range of human resources, finances, logistics, etc. needed for achieving the desired goal of protection the chosen objects.

2. FICTIONAL CASE STUDY

2.1. Description of the subjects of defense.

Consider in some fictional city, let's call it *Freedom City*, where there are the following subjects for counter-terrorism protection:

1. **Stadium (during an event),**
2. **Monument of Glory,**
3. **Great Bridge,**
4. **Stock Exchange,**
5. **National Park.**

Let π_k is a priority number of subject k. The priority number in some sense reflects the priority of the subject for the society. Of course, such "scalar" evaluation is a trivialization of the problem, but this method is used in many cases by Operations Research analysts. The numerical value of π_k has to be decided by counter-terrorism experts. Let the priority numbers for the considering fictional example are:

$\pi_1 = 10$ **(possibility of loss of huge number of lives)**

$\pi_2 = 8$ (important National symbol),
$\pi_3 = 5$ (important transport link),
$\pi_4 = 7$ (destruction may lead to a large scale economical chaos),
$\pi_5 = 1$ (city's symbol, few living buildings).

For the beginning, we do not pay attention on the specific of the protected subject, (human, economical or political). These factors might be taken into account on the further stages of the research.

2.2. Description of attack types.

Consider possible types of terrorists' attacks on the listed subjects and measures of protection.

Stadium

Possible types of attacks:
- Suicide bomber
  Form of protection:
  (1) Police at the entrance visually checking suspicious
   objects (big bags, suitcases, etc.); explosive-sniffing trained dogs are used.
  (2)Strong visa checking on the country boarders to avoid penetrating terrorist.
  (3) Gathering information about unusual or suspicious activity within
  Freedom City community of possible origin of terrorism support.
  (4) Emergency state of paramedic service of Freedom City
- Private planes or helicopters used as kamikaze.
  Form of protection:
  (1) Semi-military police helicopter barraging around the stadium with the weapon
     possible to destroy unexpected flying object.
  (2) Attentive scrutiny of candidates for pilot training schools.
  (3) Emergency state of paramedic service of Freedom City
- Regular civil planes.
  Form of protection:
  (1) Hardener checkpoints at airports (with inevitable "politically non-correct" profiling
     by names and appearance).
  (2) Presence of marshals at each flight between large cities.
  (3) Emergency state of paramedic service of Freedom City.

Monument of Glory

Possible types of attacks:
- Suicide bomber
  Form of protection:
   (1) Police at the enter of the Monument of Glory for visual checking suspicious objects
   (big bags, suitcases, etc.); using explosive trained dogs.
   (2) Strong visa checking on the country boarders to avoid penetrating terrorists.
- Private planes or helicopters
  Form of protection:

(1) Semi-military police helicopter barraging around the stadium with the weapon possible to destroy unexpected flying object.

(2) Attentive scrutiny of candidates for pilot training schools.

- Regular civil planes

Form of protection:

(1)   Hardener checkpoints at airports (with inevitable "politically non-correct" profiling by names and appearance).

(2)   Presence of marshals at each flight between large cities.

(3)   Emergency state of paramedic service of Freedom City.

Great Bridge

Possible types of attacks:

- Suicide car-bomber

Form of protection:

(1) Police at the entrance of the bridge checking suspicious vehicles.

(2) Police checking suspicious vehicles entering Freedom City.

(3) Strong checking all employees at transportation organizations (with inevitable "politically non-correct" profiling by names and appearance).

(4) Strong visa checking on the country boarders to avoid penetrating terrorists.

- Bomb at the pier of the bridge

Form of protection:

(1) Control for suspicious diving activity in the area.

(2) Control for suspicious boat movement on the river under the Great Bridge.

(3) Strong checking all owners of boats in the basin.

Stock Exchange

Possible types of attacks:

- Suicide car-bomber

Form of protection:

(1)   Police at the entrance of the street to the Stock Exchange checking suspicious vehicles.

(2)   Police checking suspicious vehicles entering Freedom City.

(3)   Strong checking all employees at transportation organizations with inevitable profiling by appearance, names and the country of origin.

Strong visa checking on the country boarders to avoid penetrating suspected terrorists.

- Suicide bomber

Form of protection:

(1) Police at the Stock Exchange visually check suspicious objects (big bags, suitcases, etc.); using explosive-sniffing trained dogs.

(2) Strong visa checking on the country boarders to avoid penetrating terrorists.

National Park

Possible types of attacks:
- Suicide bomber
  Form of protection:
  (1) Police at the entrence observe more carefully visitors of the National Park.
  (2) Strong visa checking on the country boarders to avoid penetrating terrorists.

From brief analysis of measures above, one can see that some measures are local and specific for a particular subjects of protection, some of them are common for objects within a particular region (or area), and, finally, some measures protect all subjects in the country.
For instance,
- Police checking suspicious vehicles entering Freedom City,
- Gathering information about unusual or suspicious activity within some communities

are local measures effective for entire Freedom City but only for this city.
At the same time, such measures as:
- Strong visa checking at the country boarders
- Attentive attendees checking at the pilot training centers (with strong profiling of the trainees)
- Hardener checking at airports, especially to and from main cities
- Putting marshals at the civil planes

influence on the subjects of protection within entire country. All counter-terrorism pre-emptive strikes abroad always effect on the level of entire country.

2.3. Measures of defense, its effecticeness and related expenses.

Below we consider the simplest case study for the situation described above. All numbers are fictional. Expenses for various protection measures taken in some conditional units, *CU*.

Governmental (all-country) level of protection:

Type of protection measure	Protection level		Related expenses	
Attentive visa issuing in respect to nationality and country of applicant	$F_{1(1)}$	0.9	C_{11}	5 CU
	$F_{1(2)}$	0.95	C_{12}	10 CU
Checking arrived passengers	$F_{2(1)}$	0.8	C_{21}	50 CU
	$F_{2(2)}$	0.9	C_{22}	100 CU
More attentive checking cargo	F_3	0.8	C_3	50 CU
Introducing strong control for staying in the country with guest visas	$F_{4(1)}$	0.8	C_{41}	300 CU
	$F_{4(2)}$	0.9	C_{42}	500 CU
Checking pilot schools attendees	F_5	0.95	C_5	10 CU
Checking employees of transportation organizations	F_6	0.95	C_6	50 CU
.....	.....	.....	.....	.....

All expenses are to protect all objects within the country, so "individual" expenses for a single object will be relatively small. (For instance, defending 10.000 objects within the country due to CHECKING ARRIVED PASSENGERS will correspond approximately 0.01 CU of expenses for each object.)

The list of possible types of protection measures on all levels, corresponding levels of protection and related expenses have to be prepared by expert familiar with security problems.

Zone (Regional) level of protection:

Every zone has to be considered individually because they have their own specific and their own measures of protection. Consider introduced above Freedom City as a zone and consider possible protection measures on zone (regional) level.

Type of protection measure	Protection level		Related expenses	
Checking incoming trucks	Z_1	0.9	C_{11}	5 CU
Police scrutiny of suspicious communities	$Z_{2(1)}$	0.8	$C_{2(1)}$	10 CU
	$Z_{2(2)}$	0.9	$C_{2(2)}$	15 CU
Control of airspace over the city	Z_3	0.95	C_3	50 CU
…..	…..	…..	…..	…..

Local (object) level of protection:

All objects have to be considered individually because they have their own specific and their own measures of protection. Besides, the same measures of protection might effect differently for different objects.

1. Stadium

Type of attack	Type of protection	Protection level		Related expenses	
Suicide bomber	Visual checking suspicious personal belongings (bags, suitcases, etc.)	$L_{1(1)}^{(1)}$	0.9	$C_{1(1)}^{(1)}$	1 CU
		$L_{1(2)}^{(1)}$	0.95	$C_{1(2)}^{(1)}$	2 CU
	Sample checking suspicious persons	$L_{2(1)}^{(1)}$	0.9	$C_{2(1)}^{(1)}$	3 CU
		$L_{2(2)}^{(1)}$	0.95	$C_{2(2)}^{(1)}$	4 CU
	Explosive-founding trained dogs	$L_3^{(1)}$	0.97	$C_3^{(1)}$	5 CU
Private plane crash	(zone level)	-	-	-	-
Airliner crash	(all-country level)				
…..	…..	…..	…..	…..	…..

2. Monument of Glory

Type of attack	Type of protection	Protection level		Related expenses	
Suicide bomber	Visual checking suspicious personal belongings (bags, suitcases, etc.)	$L_{1(1)}^{(2)}$	0.9	$C_{1(1)}^{(2)}$	0.5 CU
		$L_{1(2)}^{(2)}$	0.95	$C_{1(1)}^{(2)}$	1 CU
	Sample checking suspicious persons	$L_{2(1)}^{(2)}$	0.9	$C_{1(1)}^{(2)}$	1.5 CU
		$L_{2(2)}^{(2)}$	0.95	$C_{1(1)}^{(2)}$	2 CU
	Explosive-founding trained dogs	$L_3^{(2)}$	0.97	$C_{1(1)}^{(2)}$	3 CU
Private plane crash	(zone level)	-	-	-	-
Airliner	(all-country level)	-	-	-	-
…..	…..	…..	…..	…..	…..

3. Great Bridge

Type of attack	Type of protection	Protection level		Related expenses	
Suicide car-bomber	Police at the entrance of the bridge checking suspicious vehicles.	$L_1^{(3)}$	0.95	$C_1^{(3)}$	1 CU
	Police checking suspicious vehicles entering Freedom City. (zone level)	-	-	-	-
	checking employees of transportation organizations (country level)	-	-	-	-
Bomb at the pier of the bridge	Control for suspicious boat movement on the river under the Great Bridge.	$L_2^{(3)}$	0.99	$C_2^{(3)}$	3 CU
	Regular checking all owners of boats in the basin.	$L_3^{(3)}$	0.95	$C_3^{(3)}$	1 CU

4. Stock Exchange

Type of attack	Type of protection	Protection level		Related expenses	
Suicide car-bomber	Police at the street where Stock Exchange locates check suspicious vehicles parked at the building.	$L_1^{(4)}$	0.95	$C_1^{(4)}$	0.5 CU
	Police checking suspicious vehicles entering Freedom City. (zone level)	-	-	-	-
	checking employees of transportation organizations (country level)	-	-	-	-
Suicide bomber	Visual checking suspicious personal belongings (bags, suitcases, etc.) entering the building	$L_{2(1)}^{(4)}$	0.9	$C_{2(1)}^{(4)}$	0.5 CU
		$L_{2(2)}^{(4)}$	0.95	$C_{2(1)}^{(4)}$	1 CU
	Sample checking suspicious persons	$L_{3(1)}^{(4)}$	0.9	$C_{3(1)}^{(4)}$	0.5 CU
		$L_{3(2)}^{(4)}$	0.95	$C_{3(1)}^{(2)}$	2 CU
	Explosive-founding trained dogs	$L_4^{(2)}$	0.97	$C_4^{(2)}$	1 CU

5. National Park

Type of attack	Type of protection	Protection level		Related expenses	
Suicide bomber	Visual checking suspicious persons	$L_1^{(5)}$	0.95	$C_1^{(5)}$	1 CU
		$L_1^{(5)}$	0.95	$C_1^{(5)}$	1 CU
Strong visa checking on the country boarders	(country level)	-	-	-	-

2.4. Calculation of protection level for subjects of defense.

We will demonstrate the method only on one object.

Initial protection of Stadium

Value of expected minmax loss for Stadium is equal to:

$$LOSS_{Stadium} = \pi_1(1 - F_{1(1)}) \cdot (1 - F_{2(1)}) \cdot (1 - F_5) \cdot (1 - Z_3) \cdot (1 - L_{1(1)}^{(1)}) \cdot (1 - L_{2(1)}^{(1)}), \tag{1}$$

or after substitution of numerical data, one gets 0.0001.

Expenses related to this level of protection are equal to 55 CU on the country level , 10 CU on the zone level and 4 CU were spent at the level of the object (Stadium).
Notice that the biggest expenses were spent on the country level, though it should be "shared" between all protected objects.
Let us further consider only local level, because calculation by hand a system with hierarchical structure is too time-consuming and, in addition, the transparency of the example will be lost.
Let us rewrite formula (1) in the form

$$LOSS_{Stadium} = 0.01 \cdot (1 - L_{1(1)}^{(1)}) \cdot (1 - L_{2(1)}^{(1)}),$$

i.e. we keep only variables related to the local level. Then analyzing all possible measures we will get the following results:

Variant No.	Formula	Probab. of loss	Formula	Expenses
1	$(1 - L_{1(1)}^{(1)}) \cdot (1 - L_{2(1)}^{(1)})$	0.01	$C_{1(1)}^{(1)} + C_{2(1)}^{(1)}$	4
2	$(1 - L_{1(2)}^{(1)}) \cdot (1 - L_{2(1)}^{(1)})$	0.005	$C_{1(2)}^{(1)} + C_{2(1)}^{(1)}$	5
3	$(1 - L_{1(1)}^{(1)}) \cdot (1 - L_{2(2)}^{(1)})$	0.003	$C_{1(1)}^{(1)} + C_{2(2)}^{(1)}$	6
4	$(1 - L_{1(2)}^{(1)}) \cdot (1 - L_{2(2)}^{(1)})$	0.0015	$C_{1(2)}^{(1)} + C_{2(2)}^{(1)}$	8

In more visualized form the results are presented in figure below.
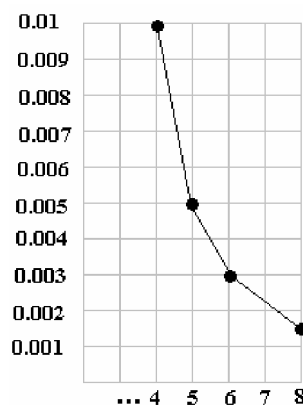
All these values can be used as members of the dominating sequences [*Kettelle, 1962*] for further analysis.

Conclusion.

The suggested computer model allows to choose balanced and effective allocation of resources between all three levels and to assign measures for each defended object depending on possible type of terrorists attack.

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