Allocating high risk locations with the Objective Ranking Tool (ORT)

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Similarity judgment is an appropriate method to compare sectors and high risk locations related to terrorism in an objective way according to a study[1] conducted in 2013 on behalf of the Dutch Government. The results of this investigation contribute to the selection of high risk locations at the defined threats. The study also provides insight into the background to the reasons why an object is designated as a high risk location. This gives both the government and the sectors involved better control options. The government is able to allocate their limited capacities. Sectors can better prioritise while achieving a desired basic security level.

Introduction

The premise is that individual companies are responsible for managing security risks such as theft, vandalism, destruction and other forms of anti-social behaviour and crime. In addition, each business has specific risks arising from the business, products or production materials.

The situation is different with terrorism. Based on the results of a risk analysis, a sector can decide to do limited or no investment at all in this type of risk. The idea behind threat levels is to prepare for this type of risk only for a limited number of objects. The selected prepatory measures should be scaled-up, in case of acute threats, to one of the defined threat levels.

Background

A unified objective method for determination of high risk locations is still missing.

Currently, for the determination of the high risk locations the sectors are using different criteria. Therefore, the existing list of high risk locations and sectors are difficult to compare. However, such a comparison is needed.

With this in mind, the sectors connected pose the questions for which locations they should be prepared for. The designation of sites as high risk locations creates obligations. On the one hand, by applying basic levels of actions, on the other hand in the adoption of additional measures that may be used during a threat, the preparation thereof, and the alignment and coordination with national and local authorities and emergency services. For some sectors, this involves significant investments, given the nature of the designated locations. During potential high threat situations, a framework to set priorities is missing to allocate scarce resources. A uniform model would make better judgments resulting in better decision-making.

The added value for the associated sectors with the use of similarity judgment is high. The model helps to makes decisions more transparent. Which objects deserve priority in realising the basic security level or form the input for investment to adjust the security level? For which objects more designated preparation is needed? Which vulnerabilities exist within the current list?

Similarity judgement

For an understanding of the operation of similarity judgement, it is necessary to present some backgrounds first. The principle is developed in cognitive psychology by Israeli Professor Amos Tversky. In his article Features of Similarity (Tversky, 1984)[2] a theoretical foundation is given for 'similarity'.

The equivalence (similarity) is expressed through a formula which is called the 'contrast' model:

$$Sij = fij / [fij + a\,(fi, \text{not } j) + b\,(fj, \text{not } i)]$$

In this expression 'Sij' is the outcome of the similarity which is a number between 0 and 1; 'fij' are the common characteristics of the compared objects 'I' and 'j'; 'fi', not 'j' are the unique characteristics of object 'I' and 'fj', not 'I' are the unique characteristics of object 'j'. The constants 'a' and 'b' sum up to 1. For each attribute a weighting factor is to be determined how much weight the feature takes in the calculation.

Prak[3] (2009) developed an application – the Objective Ranking Tool (ORT) behind this thought: "You can make a comparison between two objects in which one object is a reference location which meets all the criteria to be a high risk object. All possible locations of a certain sector can be compared to this reference object, in order to quantify the degree of equivalence. The closer the degree against '1' – a complete equivalence – the more a site is eligible for

PREFERENCE LEVEL	SCORE
Equally preferred	1
Equally to moderately preferred	2
Moderately preferred	3
Moderately to strongly preferred	4
Strongly preferred	5
Strongly to very strongly preferred	6
Very strongly preferred	7
Very strongly to extremely preferred	8
Extremely preferred	9

Figure 1 Analytic Hierarchy Process. The AHP model has a modular structure and is therefore easy to extend. Furthermore, AHP allows for sensitivity studies to investigate changes in the preference levels. If more than seven criteria within one category should be pairwise compared, the consistency in decision-making is difficult to maintain. It is then suggested to split the categories in two sub-categories, with each sub-category containing less than seven criteria.

designation as a high risk location. Indeed, the score from the model determines the degree of equivalence; the higher the score the greater the assumption that the object in question is susceptible to an attack."

Preconditions to come to a reliable determination of high risk locations are given by: 1) development of a uniform set of criteria, 2) performing the analyses in a collaborative process with stakeholders , 3) performing the analyses per type of modus operandi.

Research approach

With these considerations in mind, the research focused on the following topics:

- An analysis of the application of similarity judgment as a selection system
- A review of the results from a number of experts in the field of similarity judgment
- A method to involve experts during the use of the framework
- A method to provide assessment criteria developed by weighing
- A method of ordering of the results
- The development of a roadmap for the use of ORT.

Results

The literature survey has shown that similar applications exist in other fields. Similarity judgement is able to classify and to order objects reliably. This is also confirmed in a validation by three scientists including Prof. Gati, who together with prof. Tversky worked on the development of similarity judgement.

Within the study it is assessed how to determine the criteria, how to determine the weighting factors, and how the affiliated sectors can use the framework. For this purpose, a so-called Delphi panel is proposed. A Delphi panel is a form of expert judgement in which the deployment of selected specialists is conducted. With the deployment of specialists from different areas of knowledge, it is ensured that all relevant considerations are involved in the decision-making process.

The deployment of a Delphi panel in determining prime locations within the ATb has advantages for determining the characteristics, determining the weighting factors and in assessing whether an item/object meets the characteristics. Suggested is a Delphi panel with

Score Matrix	Objects->	Weight factor	Reference	A	B	C
First category 35%	Criterium 1	5%	1	1	1	1
	Criterium 2	35%	1	1	1	1
	Criterium 3	35%	1	0	0	1
	Criterium 4	25%	1	0	0	0

Figure 2 ORT-input. A partial example of the input. The criteria will be developed using a Delphi-panel; the weight factors will be developed using the AHP-process. The reference object is positive for each determined criteria. The Delphi-panel will score all objects –only three are mentioned: '1' object will meet the criteria, '0' the object does not meet the criteria.

Similarity Matrix	Reference	A	J	M	L	K	O	D	P
Reference	1	0,93048	0,91891	0,89958	0,89196	0,88734	0,86039	0,79168	0,73578

Figure 3 ORT-output. After running a Similarity Judgement Process, all objects will be compared to the reference. This example shows the outcome of 16 objects which are scored to 38 criteria. Only the highest eight results are presented. If, i.e., it is decided which objects are the most vulnerable for terrorism, this outcome will help to prioritise the decision-making process. In principle, ORT is a general support tool that facilitates the decision-making process for any issue.

a number between five and 10 persons to compile and build the recognised specialties. These are for example, representatives of the intelligence services, the sectors and the sciences. An additional advantage is that the acceptance of the results by all organisations directly involved is great, because of the joint effort. When applying similarity judgment within a sector, the composition of a panel may be different: for example, a representative of national government, the companies within the sector and possibly the police.

During the research phase, the methodology is studied how weightings can be set for the criteria to be used in a reliable way. For this, the Analytic Hierachy Process (AHP) is proposed. Within this method, pairwise comparisons are carried out in a structured way. In each comparison a weighting is given between features. The characteristics of the relevant equation can be equally important or they can differ in importance. Every expert performs these pairwise comparisons from which specific algorithms calculate the results and assess whether it falls within statistically reliable margins. In order to achieve consistency up to seven criteria can be compared reasonably well. This is an intensive one-off exercise that should be performed by the participants in the Delphi panel. For each characteristic a reliable weighting percentage may be identified in this way.

In assessing whether a location satisfies a certain criterion, the world is not always black or white. Sometimes a location may only fulfil for 50% to a criterion. To incorporate this separate attributes (which are true or false) and characteristics which are partially true or false are distinguished from each other. For the latter, an increasing scale is proposed by increments of 0.2.

The results of this analysis lead to a number which expresses the degree to which an object exhibits equivalence with the reference object. The higher the score, the more the object meets the criteria that determine whether an offender group may be interested in that particular object. Setting a limit, for example, all outcomes that score higher than 0.9 is not proposed. Each boundary is arbitrary. The outcome of the process only gives an ordering.

Applying such an analysis at the sector level will lead to a result by sector. A supplementary analysis within a sector will lead to a result by location. By multiplying these two results a comparison is created at the system level, in which a result from object A from sector X can be compared with object B of sector Y:

The ordering gives priority to capabilities of (central) government or the sector itself.

Completion

Sectors and high risk locations can be examined via this process in a uniform manner and can provide a ranking. Changes that result in the adjustment of the criteria can easily be incorporated. With the help of this approach, the maintenance and periodical update of the list of high risk locations is a simple process.

All this helps to bring the preparation of threat level situation to a higher level, to clarify expectations between involved parties, to respond to changing circumstances and, in times of threats, to act quickly and professionally.

Table 1

Sector	Result	Object	Result	Total (sector x object)	Ordering
X	0,84	A	0,78	0,6552	4
		B	0,86	0,7224	2
Y	0,91	C	0,74	0,6734	3
		D	0,82	0,7462	1

References

1. According to a study by the offices of PSJ and PSCT regarding the applicability of this method
2. Tversky, A. (1984 (4)). Features of similarity. Psychological Review, 327-352.
3. Peter Prak, Research into the application of similarity judgment in determining alert locations within the railway sector (2009). The public version of this thesis is available via www.psjadvies.nl/informatie.html.

Co-authors

The study was executed together with Prof. Dr. Ir. Pieter van Gelder (Delft University and PSCT) and Dr. Yuliya Avdeeva (PSCT)

Peter Prak has worked at ProRail since 1983. He was appointed as Program Manager for Security in 2006. Peter developed the security model for the Dutch rail infrastructure. He graduated in 2009 with a Master of Security Science and Management from Delft University where he developed a scientific based model to allocate high risk objects related to terrorism. In his own consultancy, PSJ, Peter offers this Objective Ranking Tool (ORT) as a general decision support tool. Peter is also functional specialist in public safety and security at 1 CMI Command in the Dutch Army.

Further informatiion:

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