RATIONAL EXPERT JUDGEMENT WITHIN THE PROPERTY PROTECTION SYSTEM

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Abstract: Property protection is becoming an increasingly important concern not only for companies but also for individuals. Its importance grows not only with increasing crime but also with increasing awareness of people about the protection of their property. This article focuses on one of the issues that we encounter in processes related to the achievement of the required level of property protection and professional judgment. Expert judgment has an irreplaceable position in the whole security process. The article shows the cases in which this judgment has a meaningful significance and the principles to be followed in their use.

This article presents the approach of expert estimates needed within the model of the protection system. This procedure is characterized in five stages and the methods used in this process are also described.

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Introduction

The protection of property can be characterized as a process of inducing a state of security by means of protective measures aimed at preventing or stopping any activity that is contrary to the interests of the owner of the property. For example, this can include burglary associated with vandalism or events that adversely affect protected property, such as an electrical short and subsequent fire. The system of protection in relation to the protection of property is a tool used to achieve this state. This system includes individual subsystems for the protection of tangible and intangible assets (Lovecek, 2015, Boros, 2018, Velas, 2017, Rehak, 2019). For the purposes of designing a protection system, it is often beneficial to create a model that combines parameters through which the individual attributes of the system relevant to the specific protection objectives are interpreted (Figure 1, Lovecek, 2017).

Figure 1: Scheme of property protection system

From a mathematical interpretation point of view of the model of the protection system, the basic starting point is the representation of the protection system in the form of a scheme of the protected space (Figure 1). This scheme describes the arrangement of detection zones, the distribution of passive and active protection elements, as well as the possibilities of intruder movement.

In the abstract form, it is an edge-rated digraph (graph with oriented edges) $G = (V, H, c)$, where V is a nonempty finite set of vertices that model the internal arrangement of the protected space (Figure 2).

The intruder overcomes the individual zones of the protected area, and this overcoming can be characterized by a time interval of the duration of the event. The edge-oriented digraph of the property protection system represents the initial part defining the spatial aspects as well as the physical layout and arrangement of specific elements of protection. These elements determine the possibilities of the intruder's movement in the protected area. However, the model of the protection system contains other

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modeled parameters, for example, the response of the intervention unit, the reliability of active protection means, or the reliability of the human factor. These parameters complete the overall structure of relationships and contexts, and only on the basis of them it is possible to comprehensively assess the level of security of the protected area (Rehak, 2018). In the case of assessing the level of security of the protected area, the basic question is how to approach the quantification of model parameters, so as to allow from the point of view of reality, the authentic assessment and evaluation of the property protection system. The modeled parameters in these systems are mostly stochastic in nature (Lovecek, 2016). Therefore, to work with the model, it is necessary to describe the randomness of these parameters. A straightforward concept of describing these parameters based on the variability of statistical files is not possible in many cases because the model describes unique situations. In such cases, it is necessary to introduce an alternative method for quantifying such parameters of the protection system. The use of expert estimates in the form of subjective assessments of the randomness of phenomena proves to be a suitable alternative in this case (Kampova, 2013).

Figure 2: Edge-rated digraph of the property protection system

Source: Authors

Expert judgement

Expert judgement is used in cases where the insufficient size or relevance of data on the researched problem does not allow the use of conventional statistical methods. The only relevant alternative remains to ask the experts for their best professional assessment of the situation (Kampova, 2010). Expert judgment is the basis for a subjective interpretation of probability, which in many cases is the most appropriate way to describe the probabilistic behavior of a given risk or its factors. The method of expert assessment is based on the field of cognitive psychology, which deals with assessment and decision-making in conditions of uncertainty (Lindley, 1994). This area of psychology examines how the human mind copes with uncertainty and what are the specifics and shortcomings of human judgment in conditions of uncertainty. As stated (Hubbard, 2011), people use various mental abbreviations in judging what psychologists call heuristics. Heuristics affect the way we remember different things and how we interpret what we remember. Heuristics are the primary cause of logical errors in assessing the probability of indeterminate phenomena. Therefore, it is essential that the experts involved in the assessment are aware of the heuristics and take them into account in their judgement.

The procedure of rational professional evaluation within the model of property protection

In general, there is no general formal procedure applicable to any expert judgment situation. One of the most known procedures is the expert evaluation procedure developed at the Stanford Research Institute (Morgan, 2007). This approach was first documented by Spetzler and Holstein (1975) and it proposes to break down the process of obtaining expert evaluations from experts into five phases.

The ability to repeatedly generate unbiased and calibrated expert estimates that are applicable to asset protection models is a prerequisite for efficient database retrieval (Figure 3).

The essence of the motivation phase in the expert judgement process is to explain the aim of judgment and motivate experts for responsible evaluation. The aim of the structure creation phase is to present and possibly modify the internal structure of the judgement tasks. This structure is primarily based on the model of the problem to be solved and its parameters, which should be structured in a way suitable for expert assessment. The aim of the calibration phase is to prepare experts for the actual judgement of

probability and to make expert estimates that will not be affected by cognitive bias. Within this phase, it is necessary to acquaint the experts with the basic issues of heuristics intuitively applied in human assessment and to explain the way and techniques on how to reduce their effects in estimating the probability in the prepared assessment tasks. An important part of this phase is the practical training of experts in the form of calibration techniques. All activities of previous phases are aimed at enabling experts to make estimates within the evaluation phase that will be rational to the purpose of the assessment task. This part of the expert assessment is further specified in a separate part of this article. The last phase of the expert assessment process is the verification phase, which aims to verify the consistency and rationality of the experts' estimates obtained. In terms of time, this phase may take place during the previous phase, but it may also begin or last later after the end of the assessment meeting itself.

Figure 3: The Phases of expert judgement

Evaluation phase within the expert judgement process

The aim of this phase is to obtain expert estimates of subjective probability, which is used to quantify the parameters of the protection system models. Due to the nature of the parameter, these estimates can generally take the form of discrete or continuous probability distributions. In the case of creating parameter estimates with a discrete probability distribution, it is necessary to create probability estimates:

$$P(X = x_i) = p(x_i), \quad (1)$$

the assessed parameter X acquires values $\{x_1, x_2, \dots, x_i\}$. When it comes to estimating the occurrence of an event (1), it is sufficient to specify number p , which expresses the degree of belief that the event will occur. If it is an event that can end with a result from the set $\{x_1, x_2, \dots, x_i\}$, then it is possible to proceed by individual estimates of the respective probabilities $p(x_i)$, or it is possible to decompose the assessment task into a series of assessments of events with binary results (Hora, 2007). Various forms of expression of expert judgement can be used. In general, it is possible to use a form of probability, percentage, relative number, or odds ratio. Each form provides a different level of comfort for the experts depending on experience, knowledge, and preferences, as well as depending on the type of parameter and the assessment task. For example, the possibility that an intruder will overcome an organization's detection zone can be estimated by the expert as a probability of 0.08. The same probability can be expressed in percentage as 8%, by a relative number in the form of an expression that 1 attempt out of 12 to overcome the detection zone will be successful. A frequent expression is also the form of the odds ratio, which expresses the ratio of the relative frequencies of the occurrence of favorable and unfavorable cases. If the estimated parameter of the model values is a continuous (the breakthrough resistance time), then it is necessary to perform an expert assessment of the continuous probability distribution. The continuous probability distribution of a parameter is defined either by its distribution function or by the probability density function. Expert assessment of such a continuous distribution of the parameter X is practically realized as an estimate of several points of this function.

The point estimate can be denoted as a pair of values (p, v) , where p indicates the probability that the value of the parameter X will be less than v (2), thus:

$$P(X < v) = p_v. \quad (2)$$

The expert estimation (p, v) can be created so that during the assessment the value of p is specified, and the experts estimate the value v . In this case, the value of the quantile X_p is estimated. For example, if $p = 0.75$, it is necessary to determine the estimate that in what time it is possible to overcome the protective device in 75% of cases, or the value of v is fixed, and experts estimate the probability of p . Depending on whether the probability p or the value of v is fixed during the assessment, we denote these assessment

methods as p -methods, resp. v -methods (Hora, 2007). After obtaining a sufficient number of estimated points, it is necessary to determine an estimate of the distribution function or the probability density function on the basis of these point estimates.

The simplest way to complete this function is linear interpolation, through which it is possible to "connect" individual estimated points $\{(p_1, v_1), (p_2, v_2), \dots (p_n, v_n)\}$ by lines. Then, for any point v for which $v_i < v < v_{i+1}$ holds, it is possible to determine the corresponding probability from the linear interpolation relation (3):

$$p = p_i + (v - v_i) \frac{p_{i+1} - p_i}{v_{i+1} - v_i}. \quad (3)$$

Linear interpolation can be used especially for simple visualization of parameter uncertainty estimation (Kampová, 2010). In more demanding cases, it is necessary to find a standard class of parametric distribution and its parameters, so that it expresses as closely as possible the course of the estimated probability distribution. Such an approach to the presentation of expert estimates within asset protection systems allows us to subsequently apply methods such as basic statistical methods, Monte Carlo simulation methods or Bayesian methods of updating parameters.

As an example of the use of expert estimation in the protection of property, we present an estimate of one parameter X . This parameter is the time of overcoming the mechanical barrier. The parameter X is considered as a stochastic parameter and will be modeled as a random variable with a normal distribution. The normal distribution is characterized by two parameters, which in probabilistic models are called hyperparameters. These are the mean μ and variance σ . In this example, for simplicity, we will assume that the variance is constant. The mean value is determined by expert judgment. An example of the result of an expert assessment based on v -method is given in Table 1.

Table 1: Expert judgement		
Hypothesis o μ_k	Value of hyperparameter μ_k	Probability of hypothesis $P(B_k)$
B_1	85	0.2
B_2	100	0.4
B_3	110	0.3
B_4	125	0.1

Source: Authors

The estimated value of the mean μ_k of parameter X was estimated based on the defined four hypotheses B_k . The estimation followed the steps shown in Figure 3. For individual hypotheses, experts define the possibility that the given hypothesis is valid $P(B_k)$. In Table 1, there are four hypotheses about the mean value μ_k of the parameter X (time of overcoming mechanical barriers). The defined parameter X using its hyperparameters (average and variable) and can be processed, for example, by the Monte Carlo method, and thus it is possible to obtain a histogram of the parameter that would reflect its complete probability.

Conclusion

The need to protect property arises from legal, psychological, or other aspects. The societal demands to improve existing and propose new, more effective protection measures are considerable. Comprehensive solutions to these needs requires the introduction of a property protection system model. One of the partial problems that we encounter in practice when working with such a model is the unavailability or non-existence of sufficient empirical observations. In such a case, it is appropriate to use the methods of expert judgement. In this article, we pointed out the individual principles of expert judgement and the methods applicable to expert estimates.

Knowledge from the field of expert judgement is one of the parts needed to create complex models of property protection systems. The application of the described principles makes it possible to create expert estimates, which are the basis for other methods usable in a comprehensive approach to ensuring asset protection based on new scientific approaches in the risk management process.

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