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Developing an expert system for assessment of information-psychological influence

Bilal Zahran[1], Jamil AL-Azzeh[2], Andrii Gizun[3], Vladyslav Griga[4], Bogdana Bystrova[5]
[1,2]Department of Computer Engineering, Al-Balqa Applied University, Jordan
[3,4,5]National Aviation University, Kosmonavta Komarova, Ukraine

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ABSTRACT

Nowadays solving practical problems in various sectors using intelligent solutions, based on expert systems are becoming more and more widespread. In this paper an expert system method is proposed for assessment and prediction of destructive influences. All disadvantages of existing assessment systems are taken into account during the development and analysis phases. The most important estimated parameters are determined. This method is based on quantitative methods of expert evaluation, which gives the advantage: there is no need to collect large amounts of statistical data and clear formalization of the current situation.

Corresponding Author:

Bilal Zahran,
Department of Computer and Network Engineering,
Faculty of Engineering Technology,
Al-Balqa Applied University, Jordan.
Email: zahranb@bau.edu.jo

1. INTRODUCTION

The field of expert systems is one of the most important areas of artificial intelligence (AI). An expert system (ES) is a knowledge-based system that employs knowledge about its application domain and uses an inferencing (reason) procedure to solve problems that would otherwise require human competence or expertise. The power of expert systems stems primarily from the specific knowledge about a narrow domain stored in the expert system's knowledge base [1].

The role of expert methods assumes special importance during the period of unstable development of informational, social, economic and other processes that directly or indirectly affect the activity of public administration bodies and local governments. Thus, the intelligent, AI and expert solutions are actively implemented in priority tasks [1], risk identification and management [2], various tasks of information systems option [3], for the detection and evaluation of critical situations [4], and in sevral other fields [5-13].

The basis of such systems, besides the actual knowledge created by experts, is the so-called heuristic or production rules [3, 14]. Under such circumstances, a high degree of uncertainty in the environmental factors influence is a defining attribute, and therefore an acceptable accuracy of results cannot be provided by any statistical or other formalized methods, no matter how perfect they are [3].

Expert methods are intended to predict qualitative and quantitative characteristics, the development of which is not completely or partially subject to mathematical formalization due to the lack of sufficient and reliable statistics. The core of expert forecasting method is based on qualified specialists assessments on a

specific problem (experts or groups of experts), formed according to the certain rules for problems solving or forecasts development, the conclusions are drawn about the development paths of the forecasting object.

Among the expert techniques there are two main groups distinguished: quantitative and qualitative. Quantitative methods of expert technologies are based on the logical-mathematical and statistical methodologies application for generalizing expert opinions, testing statistical significance of the assessment results, confirming the refutation of the assessment quality in general.

Similar expert approaches were set up to create decisive rules relating to the attacker detection in the information-communication networks and systems [15] and in the method of criticality level assessment as the emergence result of the information security incidents [16].

Information Warfare (IW) can be defined as: offensive and defensive operations against information resources of a 'win-lose' nature. It is conducted because information resources have value to people. Offensive operations aim to increase this value for the offence while decreasing it for the defence. Defensive operations seek to counter potential losses in value [17]. Information-psychological influence is an important pillar of IW. IPI is a conscious activity with the aim of diverting the behavior of the other person or a group into the required direction. The quality of assessment of IPI is of great important for many sectors. Using intelligent solutions to analyze psychological behaviors are highly concerned and conducted by researchers [18, 19]. In this paper, we developed an assessment sytem based on quantitative methodology of expert system for assessment of IPI destructiveness. The process of destructive information-psychological influences assessment will begin with the estimated parameters selection to determine the criticality level of the IPIs. There is a description of possible estimated parameters set that will be the most versatile in this context. In our work, eight criteria were selected as estimated parameters, which, based on the analysis, were determined to be the most versatile in this context and those that have the greatest impact on the IPIs success.

2. THE PROPOSED METHOD

The evaluation system of destructive information-psychological influence is based on quantitative methods of expert evaluation, since the estimated parameters are fuzzy, and the collecting a large amount of statistical data is too complicated and time-consuming process. It is the quantitative assessment that enables the further processing of the information-psychological influences (IPIs). The assessment method of destructive information-psychological influence consists of the following stages:

2.1. The Set Formation of Estimated Parameters

The process of destructive information-psychological influences assessment will begin with the estimated parameters selection to determine the criticality level of the IPIs. There is a description of possible estimated parameters set that will be the most versatile in this context. In this work, eight criteria were selected as estimated parameters, which, based on the analysis, were determined to be the most versatile in this context and those that have the greatest impact on the IPIs success.

Such criteria are: CAS - Completeness and Argumentation Strength, CPOS - Consistency with Public Opinion Standards, ACIS – Associations, caused by the information source, PR - Public Response, FAI – the Factor of anxiety increase, DR - 'Distribution rate', NAT - 'Number of affected targets', DT - 'Duration'.

For each information-psychological influence that comes from a plurality, a 'parameter-IPI' bunch is formed. This bunch will include the most specific for IPI estimated parameters chosen according to the expert. Mathematically, the bunch is described by the following expression $IPSI_j \to P_i = \{P_1, P_2, ..., P_n\}$, where P_i - the set of parameters characteristics for the certain IPI.

2.2. The Definition of the Coefficients Significance of the Relevant Estimated Parameters

The method of quantitative paired comparison with the square root definition, which is a kind of quantitative paired comparison method, is used for this. The paired comparison is an establishment procedure of preferences alternatives when comparing all possible pairs and further organizing objects based on comparison results [16]. The paired comparison method is one of the most widely used expert procedures for determining the relative weights of objects.

Among the methods of expert assessment used to obtain the coefficients of relative importance of the factors (parameters, characteristics, direction of development, etc.), the method of paired comparisons is considered to be a very effective, because it allows to define the relative importance of factors when direct comparison becomes difficult.

This is based on a comparison of each of the table options and paired comparison of matrix formation $A = \|a_{ij}\|$, where a_{ij} is selected according to the expert opinion on the scale of relative importance: 1 – alternatives are equally important, 3 – moderate advantage of one parameter over another, 5 – a significant advantage of one parameter over another, 7 – a significant advantage (convincing evidences are available), 9 – obvious advantage of one of the parameters; 2, 4, 6, 8 – the intermediate solution.

The expert fills the table cells of the factor comparison with itself and gives a one. In the first cell of the first line, the expert writes a one, in the second - the result of the first factor comparison with the second, in the third - the result of the first factor comparison with the third, etc. Passing to the second line, the expert writes in the first cell the result of the second factor comparison with the first, in the second - one, in the third - the result of the second factor comparison with the third, etc. [16, 20].

The next step is to calculate the weight coefficients according to the expression $\omega_i = \sqrt[n]{\prod_{i'=1}^{I} a_{ii'}}$, where $i' = \overline{1, I}$, where I – the number of estimated parameters, in this case. After that the valuation of the obtained coefficients by the formula $\Omega_i = \omega_i / (\sum_{i=1}^{I} \omega_i)$ is made in such a way that $\sum_{i=1}^{I} \Omega_i$. It is also worth noting the following advantages of the paired comparison method:

a) It is possible to measure the unevenly changing values of the indicators;
b) There is a large number of each indicator comparisons with others;
c) the method allows obtaining not only the average estimation score given by the expert, but also the variance of this estimation, which allows for a more extensive statistical analysis;
d) The expert in the examination process focuses on not all factors at once, but only on two, which are currently being compared (this simplifies and improves the quality of the examination).

There is an example for determination of the coefficients of importance for the predetermined valuation parameters (Table 1). The expert evaluates the importance of each of them in comparison with the other and puts the information in the table. The coefficients of importance are calculated and their rationing is carried out.

Table 1. The result of the Paired Comparison of the Estimated IPI Parameters

i/i'	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	ω_i	Ω_j
P_1	1	5	2	1/5	1/7	3	4	6	1,45	0,15
P_2	1/5	1	1/4	5	5	1/4	1/3	1/2	0,69	0,07
P_3	1/2	4	1	1/7	1/5	4	1/2	1/3	0,66	0,07
P_4	5	1/5	7	1	1/5	4	5	2	1,65	0,17
P_5	7	1/5	5	5	1	5	6	3	2,73	0,29
P_6	1/3	4	1/4	1/4	1/5	1	¼	5	0,61	0,06
P_7	1/4	3	2	1/5	1/6	4	1	7	1,04	0,11
P_8	1/6	2	3	1/2	1/3	1/5	1/7	1	0,50	0,05
									8,48	1,00

2.2.1 Ranking of the estimated parameters;

The next step is to conduct a ranking of the estimated parameters on the calculated and normalized factors of importance. As a result of calculations, the parameter 'The Increase of Anxiety Factor ' gets the highest score, and therefore, according to the expert, is the most priority among the other parameters.

2.2.2 Expert evaluation of parameters;

The next step is to provide an expert assessment of each of the estimated parameters. The scale of influence importance of each parameter is formed. This scale will be the only one for all estimated parameters and will characterize their level of influence according to indicators that range from 'low' to 'critical' level of influence.

$$E = \left\{ \begin{array}{l} \text{L ("low") - 0 points} \\ \text{A ("average") - 1 point} \\ \text{AA ("above average") - 2 points} \\ \text{H ("high") - 3 points} \\ \text{C ("critical") - 4 points} \end{array} \right\}$$

Table 2. Ranking of the Estimated Parameters by Factors of Importance

Estimated parameter, P_i	Coefficient of importance
'The Increase of Anxiety Factor	0,292
Public reaction	0,176
Completeness and argument strength	0,155
The number of affected targets	0,110
Consistency with the public opinion standard	0,06
Associations that cause the information source	0,078
Propagation rate	0,065
Duration	0,054

The experts then put out scores in accordance with what each parameter is considered to be important, and the average score is calculated (Table 3), using the rank transformation method as in [15].

Table 3. Expert Evaluation of Parameters, EP

P_i	E_1	E_2	E_3	E_4	$\sum E_{P_i} / N_{E_{P_{ii}}}$
P_1	3	2	1	2	2
P_2	0	2	1	4	1,75
P_3	3	2	1	3	2,25
P_4	2	2	3	3	2,5
P_5	3	4	2	2	2,75
P_6	3	1	2	2	2
P_7	2	1	2	1	1,5
P_8	1	1	2	0	1

2.2.3 Determination of the general level of destructiveness;

After the weight coefficients and expert estimates have been calculated according to each parameter, there is a possibility to assess the criticality level of a specific IPI. The categories of information-psychological influences come from the external detection system and IPIs identification, which is constructed by analogy with [21].

Then a direct assessment of the influence criticality is carried out in accordance with the following expression $D_{IPSI_j} = \sum_{i=1}^{I} E_{P_i} * \Omega_i$, where E_{P_i} and $_i\Omega_i$ are the coefficient of significance and the expert evaluation obtained at the previous stages.

3. RESULTS AND ANALYSIS

As an example, we will demonstrate armed rebellions in Syria in 2012 and associated with this misinformation. So, on July 17, 2012, the Syrian ex-ambassador to Iraq turned over to the rebel side. He said in the interview to BBC that '... the in the country is ready to use chemical weapons if it turns out hopeless situation [22]. Next several of the world's MEDIA have spread the news about ruling regime is ready to use chemical weapons against rebels. Thus, propaganda has influence on the psychology of information consumers.

It has been determined the most characteristic parameters for current IPI: **CSA** (Completeness and argument strength), **ACIS** (Associations caused by the information source), **PR** (Public reaction), **GAF** (Growth of anxiety factor), **PR** (Propagation rate).

For each of the options the importance criteria, according to a survey conducted earlier paired comparisons, are: CAS-0.155, ACIS-0.078, PR-0.176, FAI-0.292, DR-0.065. Then an expert assessment of each of the parameters is carried out according to the influence degree. The results are presented in Figure 1.

The next step is to conduct an immediate assessment of the influence given by IPI D_{IPSI_1}, which in this case is 3.8265. Thus, the level of criticality of this IPI is quite high and, as history shows, these estimates are not baseless. Figure 2 shows the graph, which displays the level of criticality for each of the options and for clear understanding there is the rendering of the General level of information-psychological influence criticality on the timeline.

	Expert 1	Expert 2	Expert 3	Expert 4	Average
P1	2	4	3	4	3.25
P2	4	3	2	1	2.5
P3	4	3	3	3	3.25
P4	4	4	2	3	3.25
P5	4	3	4	4	3.75
P6	2	3	4	1	2.5
P7	2	4	3	3	3
P8	2	3	3	3	2.75

Figure 1. Results of expert evaluation

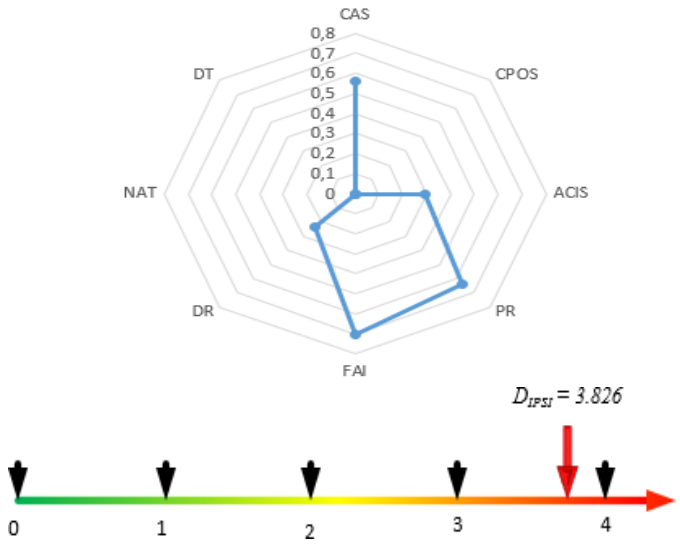

Figure 2. Visualization of the criticality level

As another example, we use the example of the political anti-advertising campaign of the election company P. Poroshenko - the video 'To live in a new way'. It is quite professional and in all respects has been created by advertisers from hostile to Petro Poroshenko of the election headquarters, and not by ordinary network users who express their dissatisfaction with the candidate. According to the experts' opinion, the characteristic parameters for this IPI will be: CAS – Completeness and argument strength; CPOS – Consistency with the public opinion standards; ACIS – Association that causes the source of information; DR – Distribution rate and duration; PR – Public reaction.

The scale of importance criteria will be the same as in the previous experiment, that is, with the following values CAS - 0.292, CPOS - 0.073, ACIS - 0.078, DR - 0.065, DT - 0.054, PR - 0.176. Expert assessments will have the following form (Figure 3).

	Expert 1	Expert 2	Expert 3	Expert 3	Average
P1	2	3	2	2	2.25
P2	2	3	1	2	2
P3	3	2	1	4	2.5
P4	3	3	3	3	3
P5	2	1	3	4	2.5
P6	2	3	2	1	2
P7	4	2	1	1	2
P8	4	4	1	2	2.75

Figure 3. Expert evaluations of parameters importance

The result of the IPI assessment in this case $D_{IPSI_2} = 1,4851$. Figure 4 shows that the public reaction is the determinative factor.

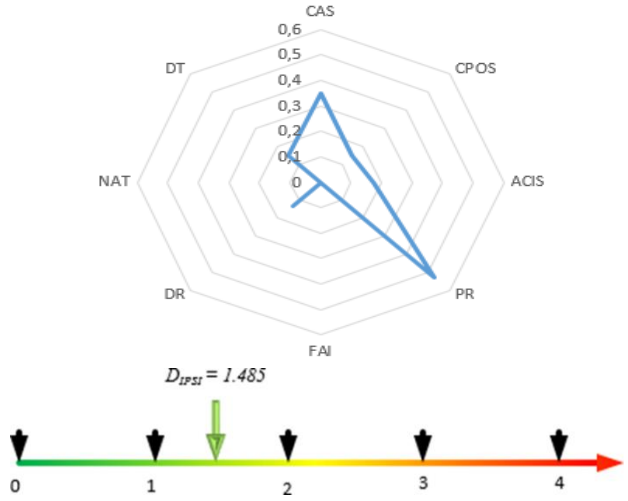

Figure 4. The level of criticality visualization

The overall level of criticality is below the average, which was observed in the real situation, since anti-aggression did not give a positive result despite all the efforts.

4. CONCLUSION

We decided to use an expert approach due to the several disadvantages of other assessment systems of influences on the society consciousness or individual. Thus, the assessment method of IPI destructiveness based on quantitative methodology of expert evaluation has been developed. As input parameters in the method the values of the generated universal estimation parameters are taken. Thus, the main advantages of the method are there is no necessity to collect large amounts of statistical data and accurate formalization of the current situation, as well as a low resource intensity The experiment, based on the analysis of real events, showed the proximity of the obtained estimates of IPI destructiveness to the real indicator of its impact. That is, in practice, the authenticity and adequacy of the proposed method was confirmed.

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