Usage of Expert Decision-Making Support Systems in Information Operations Detection

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***Abstract*—In this paper a methodology for application of expert data-based decision support tools while identifying informational operations is suggested. The methodology utilizes expert data, obtained through group expert examinations using the respective tools, enabling experts to work remotely in a global network. Based on information, obtained from experts, the knowledge engineer builds the knowledge base of subject domain, using the respective decision support tools. The knowledge base, in its turn, provides the basis for specification of queries for analysis of dynamics of respective informational scenarios using text analytics means. Based on results of the analysis and the knowledge base structure, decision support tools calculate the achievement degree of the main goal of the informational operation as a complex system, consisting of specific informational activities. After that, using the results of these calculations, decision-makers can develop strategic and tactical steps to counter-act the informational operation, evaluate the operation's efficiency, as well as efficiencies of its separate components.**

Keywords*—*information security, informational operation, decision-making support system, expert estimate, content-monitoring system.

I. Introduction

Given the present level of development of information technologies it is hard to overestimate their impact to human life. Information media, into which every man, any social group, population are involved, forms the respective world-view, affects their behavior and decision making. Therefore, the problems, related to formation and modification of this information media, are extremely actual nowadays.

By information operation (IO) [1], [2], [3] we assume the complex of information activities (news articles in Internet and papers, news on TV, comments in social networks, forums, etc.) aimed to change the public opinion about a definite object (person, organization, institute, country, etc.). For example, spreading the rumors about problems in a bank can provoke its depositors to take back their deposits, which in turn can cause its bankruptcy. Mainly, this activity has a disinformation character. The information operation belongs to so called weakly structured subject areas [4], [5], because it possesses several characteristic for these areas features: uniqueness, inability to formalize the objective of its function and, as a consequence, inability to construct the analytical model, dynamicity, incompleteness of description, presence of human factor, absence of standards. These subject areas are treated using expert decision-making support systems (DMSS) [6].

In [1], [2], [3] the techniques are presented of IO identification based on the analysis of time series built on the basis of thematic information stream monitoring. The following problematic situations which can appear in IO identification due to drawbacks of current methods and techniques can be noted:

1) Given a sufficiently large number of publications about the IO object, the number of publications (information stove-piping) about its definite component can be very small and, as a consequence, the respective system distortions of the typical dynamics of information plots (such as, for example, discovered "Mexican hat" and Morlet wavelets on the respective wavelet scalogram) will not be revealed. Some IO may be complex and respective information stove-pipings may be staged, related to different components of the IO object in different time periods. If their number will be blurred at the background of the total number of publications about the IO object ("information noise") and the respective information attacks will not be identified, then the beginning of the information campaign on the object discredit can be missed, and some information damage to its image will not be taken into account.
2) Content-monitoring tools control the queries consisting of keywords to search the respective publications. Keywords are formed based on the IO object title. But the complex IO object can have a great number of components with the respective titles which are not accounted in queries and, as a consequence, not all publication on the issue will be found.
3) The queries related to IO object have different degrees of importance according to IO components to which they are related. The absence of information about values of these importance degrees (i.e. their equivalence) leads to the reduction of the IO model relevance.

To overcome the above-mentioned drawbacks we suggest using the following technique for application of decision making support tools in IO revealing.

II. The core of the methodology for application of expert decision-making support tools in identification of information operations

The core of the suggested methodology for application of expert decision making support tools in identification of information operations consists in:

1) Preliminary investigation of the IO object is carried out; its target parameters (indexes) are being selected. Then it is suggested that formerly, in retrospective, IOs against the object were taking place, and, thus, its condition (respective target indices) has been deteriorated.
2) The group expertise is done to determine and decompose the information operation purposes and to estimate its degree of influence. Thus, the IO object is being decomposed as a complex weakly structured system. For this purpose the tools of distributed acquisition and expert information processing system (DAEIPS) are used. For obtaining the expert information in a full range and without distortions the expert estimation system is used.
3) The respective knowledge base (KB) is constructed using the DMSS tools, based on the results of the group expertise performed by means of DAEIPS and using available objective information.
4) The analysis of the dynamics of the thematic information stream by means of content-monitoring system (CMS) is carried out. KB of DMSS is complemented.
5) The recommendations are calculated by means of DMSS based on the constructed KB. For this the IO target achievement degrees are calculated in retrospective and are compared with the respective changes of the IO object condition. The mean value of IO target achievement degrees is calculated, at which degrees the deterioration of the IO object target indices occurs. Thus, monitoring of the IO object condition for the current period of time allows one to predict the deterioration of the IO object target values based on the comparison of the calculated for the current period of time value of IO target achievement degree with the above-mentioned mean value. In the case of availability of statistically sufficient sample size, and given sufficient correlation between values of IO target achievement degrees and deterioration of IO object target index values, one can even predict the quantitative value of the IO object target index for the current period of time.

Let's consider the advantages of the suggested methodology. The great specification of the model – at the background of a large number of publications about IO object in general, the change in publication number dynamics due to the stove-piping about one of IO components will be insignificant and, therefore, will not be revealed. The number of found thematic publications will increase, because of a larger number of queries and keywords. Weighing of the IO components allows one to avoid the situation when all components are of equal importance. The IO model constructed in such a way will be more relevant. The constructed KB can be used again later during a long period of time without the necessity to carry out a new expertise. The use of DAEIPS tools makes it possible for experts to work through the global network saving time and resources.

Let's consider the drawbacks of the suggested methodology. Application of expert techniques requires time and financial efforts for implementation of the group expertise. Besides, the timely actualization of KB should be done for its second use in the future. Complexity and sometimes ambiguity of the presentation of some sufficiently complex statements of IO components in the form of queries in the content-monitoring system.

III. Example of the use of the methodology for application of expert decision-making support tools in identification of information operations

Let us show in detail the suggested methodology at the example of information operation against National academy of Sciences (NAS) of Ukraine. It is known that presently NAS of Ukraine is going through hard times. In recent years the funding of NAS is getting worse: the total funding of NAS of Ukraine decreases and also decreases the share of the budget of NAS of Ukraine in the total budget of Ukraine. This is well seen from the information about distribution of expenses for the State Budget of Ukraine for 2014 – 2016 [7], [8], [9]. Suppose that this cut of funding is the result of information operation against NAS of Ukraine.

A. Group expert decomposition in "Consensus-2" system

As DAEIPS for group expert decomposition we use "Consensus-2" system aimed to perform estimations by territorially distributed expert groups. This system is an upgraded version of "Consensus" system [10]. In DAEIPS "Consensus-2" the technique of KB construction is implemented for weakly structured non-formalized subject areas in the form of hierarchies of targets. "Consensus-2" system consists of two computer-aided working places: for an expertise organizer (knowledge engineer) and for an expert.

The group expertise consists of a set of stages, each being monitored by the knowledge engineer. He also initiates the transition from one stage to another. First, the expert is asked the following question: form the list of essential factors affecting the achievement of the target "Information operation against National academy of sciences of Ukraine". Now the expert introduces new statements or chooses the factors from the list of objects already present in KB. Then, when the expert group introduces a sufficient number of statements, the knowledge engineer selects the groups of the statements with the same meaning from all the statements introduced during the current decomposition. At the next stage in each semantic group the experts choose the best (by their opinion) statements and the respective voting is carried out. Then the knowledge engineer determines the types of influence of the factors. If the factor facilitates the achievement of the target, then the influence is considered as positive, if it prevents, then it is negative. At the final stage the respective graph of the hierarchy of targets is drawn (Fig. 1).

Next, the knowledge engineer chooses the target in the graph which will be expanded by the expert group at the

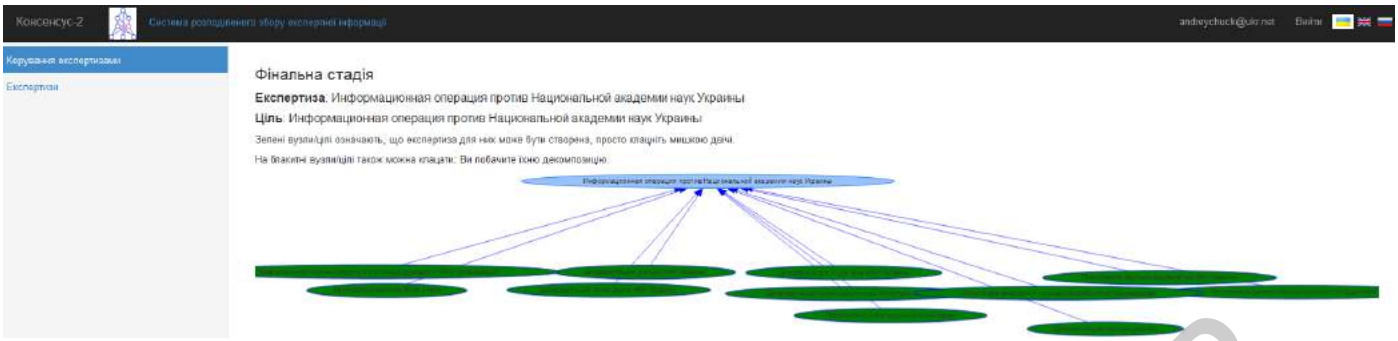

Figure 1. Decomposition of the main target in “Consensus-2” system

following decomposition step. Several targets can be expanded in parallel.

In the same manner the decomposition of other targets in the hierarchy is performed. As a result, the respective knowledge base tables are generated. Then DMSS forms the KB based on the interpretation of these intermediate data.

B. Knowledge base construction in DMSS “Solon-3”

DMSS “Solon-3” [11] is developed for the decision support in planning the large-scale complex long-term programs, including those for making strategic plans in different fields of activity. The system makes it possible to estimate and select various political, social, economic and other measures (solution variants) depending on their influence on the achievement of the main and intermediate targets of the program. “Solon-3” system allows one also to optimally distribute the available resources and to plan implementation of measures. During the estimation numerous complex interconnections of the factors affecting the achievement of the program’s target are being taken into account. DMSS “Solon-3” is the multi-user system, the knowledge base of which is formed by many experts and specialists of highest rank in different areas of knowledge.

In DMSS “Solon-3” the original method is used based on decomposition of the main objective of the program, construction of the knowledge base (hierarchy of targets) and dynamic target estimation of alternatives [6].

Based on the interpretation of the knowledge base generated after operation of DAEIPS “Consensus-2” in previous chapter, DMSS “Solon-3” generates the respective KB. The knowledge engineer has an option to edit KB by system tools, namely: to introduce new targets/projects/connections, to edit/delete present targets/projects/connections, to introduce partial coefficients of influence according to the results of the group expertise, and also to introduce “objective (non-expert)” information and other functions.

C. Expert estimation in “Level” system

The software for an expert estimation using pair comparisons “Level” (“Riven”) [12] is developed for execution of the expertise in decision making support systems and allows one to obtain knowledge from experts by offering them a possibility to compare the objects pairwise. It allows an expert to specify the existence of preference between the objects with an option to increase gradually the degree of this preference to the level corresponding to the actual knowledge of the expert about the object. In every distinct pair comparison the expert has an option to choose his own convenient scale with the respective number of divisions. That means that information from an expert is obtained in full volume and without pressure, which could distort it in respect to the expert’s own impression.

Fig. 2 shows how the expert pair comparison is performed in “Level” system, namely: specification of the degree of influence superiority in the integral verbal scale with 9 divisions.

D. Analysis of thematic information stream by means of content-monitoring system InfoStream

In the result of described in previous chapters group expertise 15 expert statements were obtained presenting the components of IO against NAS of Ukraine, namely:

1) Bureaucracy in NAS of Ukraine;
2) Inefficient personnel policy of NASU;
3) Corruption in NAS of Ukraine;
4) Underestimation of the level of scientific results of NAS of Ukraine;
5) Lack of introduction of scientific developments into manufacture;
6) Underestimation of the level of international collaboration;
7) Misuse and inefficient use of the realty of NASU;
8) Misuse and inefficient use of land resources of NASU;
9) Discredit of President of NAS of Ukraine;
10) Discredit of Executive secretary of NAS of Ukraine;
11) Discredit of other well-known persons of NAS of Ukraine;
12) Juxtaposition of scientific results of Ministry of Education and Science (MES) and NAS;
13) Juxtaposition of scientific results of other academic organizations to NAS;
14) Juxtaposition of developments of Ukrainian companies to NAS of Ukraine;
15) Juxtaposition of scientific results of foreign organizations to NAS.

By means of CMS InfoStream [13] the analysis of thematic information stream dynamics is made. For this, in accordance with every of above-listed IO component, in the special

Figure 2. Expert pair comparison in the “Level” system

language the queries are formulated, using which the above-mentioned process – the analysis of publication dynamics on target issues – will take place.

Below the results are presented of the express-analysis [2] of thematic information stream corresponding to the IO object – NAS of Ukraine. In the result of the analysis by means of CMS InfoStream the respective information stream from the Ukrainian segment of web-space was obtained. To reveal an information stove-piping, the publication dynamics was analyzed on the target issue using available analytical tools. In Fig. 3 one characteristic fragment of the dynamics is shown (for the period from 01.07.2015 to 31.12.2015).

To reveal the degree of similarity of fragments of respective time series to IO diagram in different scales one can use the “wavelet analysis”. Wavelet coefficients show to which extent the behavior of the process in a definite point is similar to the wavelet in a definite scale. In the respective wavelet spectrogram (Fig. 4) all the characteristic features of the initial series can be seen: scale and intensity of periodic variations, direction and value of trends, presence, position and duration of local features.

The IO dynamics most exactly is represented by “Mexican hat” and Morlet wavelets [14]. Therefore, the time series according to each of 15 IO components are analyzed during four periods (01.01.2013-31.12.2013, 01.01.2014-31.12.2014, 01.01.2015-31.12.2015 and 01.01.2016-15.12.2016), and the presence of the above-mentioned wavelets is identified.

E. Calculation of recommendation using DMSS ‘Solon-3”

Based on revealed in the previous chapter information stove-pipings and their parameters (position and duration) the knowledge engineer complements KB of DMSS “Solon-3”. In particular, the stove-piping was identified on the IO component “Underestimation of the scientific results of NAS of Ukraine” situated at 30.11.2015 with the duration of 14 days. Correspondingly, as a characteristic of the project “Underestimation of the scientific results of NAS of Ukraine” the parameter of duration of the project execution of 14 days is introduced, and as a characteristic of the project “Underestimation of the scientific results of NAS of Ukraine” influence on the objective “Discredit of scientific results of NAS of Ukraine” the parameter of delay in influence distribution for 10 months term is introduced. For other revealed information stove-pipings the characteristics of projects and influences are introduced in the similar manner.

Thus, for the time period 01.01.2015–31.12.2015, KB is complemented and has the structure shown in Fig. 5. Correspondingly, Table I contains the list of statements of all targets and projects of KB.

It should be noted that for some IO components, namely: “Corruption in NAS of Ukraine”, “Bureaucracy in NAS of Ukraine”, “Inefficient personnel policy of NASU”, “Misuse and inefficient use of land resources of NASU” and “Misuse and inefficient use of the realty of NASU” stove-pipings were revealed twice during 2015, therefore, respective projects were entered into KB twice each. For example, for the IO component “Bureaucracy in NAS of Ukraine” – projects “Bureaucracy in NAS of Ukraine 1” and “Bureaucracy in NAS of Ukraine 2”, but each of them has different characteristics of the execution duration (9 and 15 days) and respective influences have different characteristics of delay in distribution (9 and 11 months).

Then in DMSS “Solon-3” degrees of project implementation are introduced. If for some IO components no stove-piping was found, as in particular, for “Juxtaposition of developments of Ukrainian companies to NAS of Ukraine” and “Discredit of the actions of the Case Management department of NASU”, then for respective projects the implementation degrees equal to 0% are set. For all other projects they equal to 100%.

Next, the results are obtained of the calculation of recommendations, namely: the degree of achievement of the main IO target and of project efficiency (relative contribution into achievement of the main target). For the periods 01.01.2013-31.12.2013, 01.01.2014-31.12.2014, 01.01.2015-31.12.2015 and 01.01.2016-15.12.2016 the degrees of achievements of the main target have values: 0.380492, 0.404188, 0.570779 and 0.438703, respectively.

In the retrospective, the mean value of the degree of achievements of the main target is equal: (0.380492 0.404188 0.570779) / 3.0 $\approx$ 0.45182.

Thus, since the mean retrospective and current value of the degree of achievements of the IO main target are sufficiently close (differ less than by 3%), then the conclusion can be drawn that IO during the current period with high probability

Figure 3. Publication dynamics on target issue

Figure 4. Wavelet spectrogram (wavelet Morlet) of the information stream

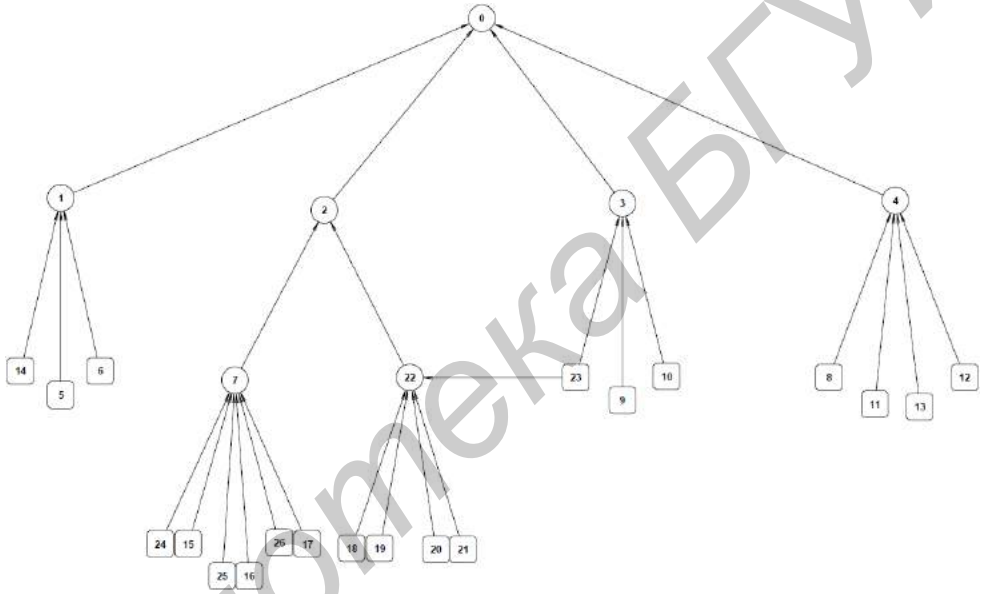

Figure 5. Structure of knowledge base

can provoke the deterioration of the target indexes of the object.

IV. Conclusions

1) The feasibility of application of expert decision making support tools is demonstrated in the process of identification of information operations.
2) The methodology is suggested for application of expert decision making support tools in revealing of information operations which allows one to predict the change of the values of target indices of the object for the current period based on the analysis of the retrospective data.
3) The suggested methodology is illustrated at the example of the information operation against National academy of sciences of Ukraine.

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Table I. LIST OF STATEMENTS OF TARGETS

#	Statement of objective
0	Information operation against National academy of sciences of Ukraine
1	Discredit of scientific results of NAS of Ukraine
2	Discredit of the structure of NAS of Ukraine
3	Discredit of well-known persons of NAS of Ukraine
4	Overestimation of scientific results of competing with NASU organizations
5	Lack of introductions of scientific developments into production
6	Underestimation of the level of international collaboration
7	Discredit of the organization structure of NASU
8	Juxtaposition of scientific results of MES and NAS
9	Discredit of President of NAS of Ukraine
10	Discredit of other well-known persons of NAS of Ukraine
11	Juxtaposition of scientific results of other academic organizations to NAS of Ukraine
12	Juxtaposition of scientific results of foreign organizations to NAS of Ukraine
13	Juxtaposition of developments of Ukrainian companies to NAS of Ukraine
14	Underestimation of the level of scientific results of NAS of Ukraine
15	Corruption in NAS of Ukraine 2
16	Bureaucracy in NAS of Ukraine 2
17	Inefficient personnel policy of NASU 2
18	Misuse and inefficient use of the realty of NASU 1
19	Misuse and inefficient use of the realty of NASU 2
20	Misuse and inefficient use of land resources of NASU 1
21	Misuse and inefficient use of land resources of NASU 2
22	Discredit of the actions of the Case Management department of NASU
23	Discredit of Executive secretary of NAS of Ukraine
24	Corruption in NAS of Ukraine 1
25	Bureaucracy in NAS of Ukraine 1
26	Inefficient personnel policy of NASU 1

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ПРИМЕНЕНИЕ ЭКСПЕРТНЫХ СИСТЕМ ПОДДЕРЖКИ ПРИНЯТИЯ РЕШЕНИЙ ПРИ ВЫЯВЛЕНИИ ИНФОРМАЦИОННЫХ ОПЕРАЦИЙ

Андрейчук О.В., Качанов П.Т.

В статье предложена методика применения инструментария экспертной поддержки принятия решений при идентификации информационных операций. Данная методика базируется на использовании экспертной информации, полученной путём проведения групповых экспертиз с помощью соответствующего инструментария для работы специалистов-экспертов через глобальную сеть. На основании полученной экспертной информации, инженер по знаниям строит базу знаний предметной области, путём применения соответствующего инструментария поддержки принятия решений. Согласно построенной базы знаний, уточняются запросы для анализа динамики соответствующих информационных сюжетов путём применения средств текстовой аналитики. Используя результаты анализа и построенную базу знаний, средствами поддержки принятия решений вычисляется степень достижения цели информационной операции, как сложной системы, компонентами которой являются конкретные информационные мероприятия. Далее, базируясь на проведённых расчётах, лица принимающие решения могут разрабатывать стратегические и тактические меры по противодействию информационной операции, оценивать её эффективность, а также и эффективности отдельных её компонентов.