

Network-centric Approach to Destructive Manipulative Influence Evaluation in Social Media

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Abstract. The mass media phenomena investigation are equipping a mankind with a broader and deeper understanding of society and culture due to the fact that the texts produced by the mass media are the most socially significant messages and have a priority in the society over all other types of texts. Moreover, in recent years, the concepts of mass consciousness influence and mass behavior influence had become increasingly popular. Frequently, mass media is the subject or instrument of such manipulation. Today Internet is digital media technology including web-sites, e-mail, Internet-radio and TV, as well as social networks and other services (so called social media). Destructive manipulative influence evaluation in social media is actual and important scientific task whichever quantitative its assessment. In this paper advanced approach to destructive manipulative influence evaluation in social media was proposed. This approach allows calculating the quantitative parameters that characterize the level of destructive manipulative influences on public opinion using channels of social media. Using this approach specialized software tools can be developed for manipulative influence automatized detection and quantitative evaluation.

Keywords: Social Media, Destructive Manipulative Influence, Quantitative Evaluation, Public Opinion, Information Psychological Security.

1 Introduction

Currently, the mass media has become the main tool for information dissemination that affect individual consciousness and subconscious and, as a consequence, the public consciousness. Public consciousness should be considered as a social phenomenon whose main function is to influence the audience through semantic and evaluative information transmitted by mass media channels. Moreover, public consciousness is a mechanism for actualizing information through various means of communication.

Therefore, mass media influence does not always have a negative effect, since in the globalized world it is difficult to imagine human life without newspapers, social networks and other mass media. However, on the other hand, some individuals, for gaining their own advantages, use mass media as an instrument of influence on society.

2 Analysis of Modern Researches Devoted to Manipulative Influence Evaluation in Social Media

The research in mass media manipulative influence field was engaged by large number of Ukrainian as well as foreign scientists.

In research papers of A. Peleschyshyn [1,2] the description of informational environment of the virtual community in social networks was described; a model of internal informational environment and the discussion model of the virtual community were developed and detailed; on the basis of a formal model of the informational environment of the virtual community, taking into account the quality of information content, the indicator of information threats is determined. These models allow organizing the detection and counteraction of the information threats and providing the information-psychological security of a person in a social network. However, a significant disadvantage of these models is the impossibility of quantity evaluation.

A human activity model and human joint activities model in the information space was proposed by A. Shiyan [3]. On the basis of proposed models, a human protection method from negative informational and psychological influence on the basis of the peculiarities of its activity was presented. However, directly, the formal protection model against manipulative influence was not highlighted, as a consequence, is not possible to evaluate mathematically the effect.

In research study of D. Gubanov [4] an overview of the influence models in social networks was presented, the main classes of models in social networks were considered and the correspondence between classes of models and parameters of the modeling object was established. An analysis of these models allows to study the relationships between objects in a social group and the dependence of information influence on persons and public opinion.

The formalized model for detecting PR-influence through Internet publications was developed by O. Khatyan in paper [5]. According to this work, PR-influence is the mass media manipulative influence. However, this model allows to identify the impact, but do not assess it. Therefore, the developed model can be used as an initial stage for the development of a further evaluation model. Proceeding from the above, a detailed analysis of manipulative influences models was conducted.

Given results of the analysis show that existed models and methods have certain limitations as to practical application for solving various kind of tasks of information and psychological security (also it can be combined with information-technical influence [6]). It is found that the evaluation method of media manipulative influence is only then effective and adequate in case it meets all the specified criteria like taking into account methods of manipulative influence or formal its description.

The main task of this paper is to develop an evaluation method of destructive manipulative influence, which will allow calculating the quantitative parameters of their influence on public opinion in social media.

3 Theoretical Background of Proposed Approach to Manipulative Influence Evaluation

After the definition of existed approach new approach based on network-centric concept [7,8] was developed. The proposed evaluation approach of mass media manipulative influence on public opinion is realized in following 8 stages:

1. Evaluation the financial costs;
2. Ranking of reasons by the degree of their danger;
3. Determination the objectives of the manipulation campaign (hereinafter – KMp);
4. Determination of the KMp tasks;
5. Determination of strategies for the KMp implementation;
6. Selection the mass media for manipulation;
7. Selection the manipulation method;
8. Estimation of manipulative influence.

These stages will be detail described after defining input and output data. The practical realization of this approach could allow evaluating the level of media manipulative influence on public opinion.

Input data: the set of reasons for conducting KMp; the set of dislocation places; the set of goals for KMp; the set of focus groups; set of criteria for estimating parameters; the set of strategies for KMp; the set of mass media; the set of manipulation methods and the set of «weight by criteria».

Output data: list of selected causes, goals, criteria, tasks, strategies, methods, mass media; values of magnitude and effectiveness of manipulative influence.

Evaluation the effectiveness of manipulative actions is the preparatory stage for conducting the campaign. This stage is only necessary for the customer – to evaluate the financial efficiency of KMp. At this stage, from the whole mass media database it is necessary to select those mass media which, in the opinion of the expert, are suitable for the implementation of manipulative influence. First of all, it is necessary to determine the economic effect of advertising in selected mass media in accordance to (1):

$$E = \frac{T_D \times H_T}{100} - (U_P + U_D), \quad (1)$$

where E is the economic effect of advertising; T_D is additional trade turnover under the advertising influence; H_T is trade margin on goods (measured in % to the realization price); U_P are advertising costs; U_D are additional expenses on the growth of goods turnover.

The next formula $\frac{Z_P}{Z_O} = \frac{Z_P - Z_O}{Z_O}$ gives an opportunity to evaluate the effectiveness of advertising in relation to the profits of the company, obtained from advertising (Z_P) to profit before advertising (Z_O).

3.1 Stage 1 – Evaluation the financial costs on KMp

Step 1 – Choosing the reasons for conducting KMp.

At the first step of Stage 1 it is necessary to input a set of reason (I):

$$I = \left\{ \bigcup_{i=1}^P I_i \right\} = \{I_1, I_2, \dots, I_p\}, I_i \subseteq I, i = \overline{1, P}$$

and experts choose those reasons (using voting method), which, in their opinion, require a KMp. After that experts go to step 2.

Step 2 – Ranking of reasons by the degree of their danger.

That is, for each possible i reason (for the period of preparation and implementation of the KMp) in r regions, it is necessary to evaluate the financial cost (u_i) for a manipulative attack using formula (2):

$$u_i = \sum_{r=1}^R \sum_{j=1}^J \sum_{t=1}^T \beta_j^r(t) \times c_j^r, r = \overline{1, R}; j = \overline{1, J}; t = \overline{1, T} \quad (2)$$

where $\beta_j^r(t)$ is the amount of mass media of j type (social networks, newspaper, TV etc.), for the period t in region r , c_j^r is the cost of one mass media of j type in region r .

Step 3 – Definition of financial constraints.

At this step, it is necessary to determine financial constraints of conducting KMp using following expression:

$$u_i \leq \sum_r \sum_{t=1}^T d_j^r(t), i = \overline{1, I}, \quad (3)$$

where $d_j^r(t)$ is the amount of possible financing of the KMp during t period in r region. As a result of Stage 1, will be received a financial statement about expenses on the KMp. Based on the report, it is possible to analyzed if KMp should be carry out from a financial point of view.

3.2 Stage 2 – Ranking of reasons by the degree of their danger

During the ranking of reasons by the degree of their danger, each expert are conducting pairwise comparison of reasons by the degree of their danger for KMp (step 1)

and create the matrix H_r (step 2) for each r region. The expert's mark define as h_{ij}^r , where i is the expert number, j is the reason number, r is the region number:

$$h_{ij}^r = \begin{cases} 1, & \text{if } I_i \text{ equal to } I_{i+1}; \\ 2, & \text{if } I_i \text{ more dangerous than } I_{i+1}; \\ 0, & \text{if } I_i \text{ less dangerous than } I_{i+1}; \end{cases} \quad (4)$$

$$H_r = \left(h_{ij}^r \right)_{\substack{(i=\overline{1,a}) \\ (j=b)}} = \begin{vmatrix} h_{11} & h_{12} & h_{1b} \\ h_{21} & h_{22} & h_{2b} \\ \dots & \dots & \dots \\ h_{a1} & h_{a2} & h_{ab} \end{vmatrix}, \quad (5)$$

Furthermore, the system agrees the expert score with one of the well-known harmonization computer algorithms. As a result of the Stage 2 implementation, will be obtained a matrix of reasons, according which it is expedient (or inexpedient) to conduct KMp.

3.3 Stage 3 – Determination the objectives of the KMp

At this stage, a set of objectives (C) must be created by experts:

$$C = \left\{ \bigcup_{i=1}^c C_i \right\} = \{C_1, C_2, \dots, C_c\}, C_i \subseteq C, i = \overline{1, c}$$

The set of objectives is a possible consequence of the reasons for conducting the KMp (step 1). Moreover, in step 2 by experts are creating the set of focus group (G) who are the target of influence:

$$G = \left\{ \bigcup_{i=1}^g G_i \right\} = \{G_1, G_2, \dots, G_g\}, G_i \subseteq G, i = \overline{1, g}$$

and criteria (Kr): $Kr = \left\{ \bigcup_{i=1}^r Kr_i \right\} = \{Kr_1, Kr_2, \dots, Kr_r\}, Kr_i \subseteq Kr, i = \overline{1, r}$, that are the parameters by which the objectives and tasks of the KMp will be selected.

As a result of the Stage 3 implementation, will be formed objectives, the focus groups who are the objects of influence are identified and the criteria (for choosing objectives and tasks) are selected.

3.4 Stage 4 – Determination of the KMP tasks

At the step 1, experts form a set of tasks (A), which are connected to the objectives of the KMP (the objectives were identified in step 3), for assessing the KMP's tasks by using (6):

$$A = \left\{ \bigcup_{i=1}^y A_i \right\} = \{A_1, A_2, \dots, A_y\}, A_i \subseteq A, i = \overline{1, y}. \quad (6)$$

At the step 2, the proportion of agreed positive scores $x_{A_i}^v$ to the criteria of each v task of each agent A_i according to all the criteria is calculated by (7):

$$x_{A_i}^v = \frac{\sum \beta_{A_i, K_{r_i}}^v}{\sum a_{A_i, K_{r_i}}^v}, i = \overline{1, v}. \quad (7)$$

As a result of Stage 4, the tasks to be achieved during KMP are formed.

3.5 Stage 5 – Determination of strategies for the KMP implementation

The objectives of manipulating different groups are made at different times t_i and with different benefits. In accordance with the formulated objectives and tasks their strategies (L) $C_i \Rightarrow L_i, A_i \Rightarrow L_i$ are selected and implemented. At the step 1, from the set of strategies experts select the strategy that require of the KMP conducting:

$$L = \left\{ \bigcup_{i=1}^m L_i \right\} = \{L_1, L_2, \dots, L_m\}, L_i \subseteq L, i = \overline{1, m}.$$

At the step 2, the list of strategies is ranking by following expression (8):

$$f_{lp} = \begin{cases} 3, & \text{if } a_l > a_p, \\ 2, & \text{if } a_l = a_p, \\ 1, & \text{if } a_l < a_p. \end{cases} \quad (8)$$

As a result of Stage 5, it is formed a number of strategies (possibly more than 1) on which KMP will be realized.

3.6 Stage 6 – Selection the mass media for manipulation

At the stage 6, it is necessary to choose mass media (Z) which will be used during manipulative influences [9-11].

Then, it is necessary to conduct an analytical study of mass media with further evaluation of the information influence effectiveness. At the step 1, a set of mass media is formed as follow:

$$\mathbf{Z} = \left\{ \bigcup_{i=1}^z \mathbf{Z}_i \right\} = \{ \mathbf{Z}_1, \mathbf{Z}_2, \dots, \mathbf{Z}_z \}, \mathbf{Z}_i \subseteq \mathbf{Z}, i = \overline{1, z}$$

Step 2 – evaluation the effectiveness of manipulative actions can be presented using following formula (9):

$$c_{Z_i G_i}^{R_i} = \frac{a_{Z_i G_i}^{R_i}}{b_{Z_i}^{R_i}}, \quad (9)$$

where $a_{Z_i G_i}^{R_i}$ is a score of z mass media in g -th focus group in r region, $z = \overline{1, Z}$, $g = \overline{1, G}$, $r = \overline{1, R}$, $b_{Z_i}^{R_i}$ is a score of z mass media of population in r -region, $c_{Z_i G_i}^{R_i}$ is a compliance index of z mass media in g -th focus group in r region. Thereafter, the mass media price matrix (10) is created and stored in database of manipulation system:

$$D_{zp} = \begin{vmatrix} d_{1Z} & \dots & d_{1P} \\ \dots & \dots & \dots \\ d_{Z1} & \dots & d_{P1} \end{vmatrix}, \quad (10)$$

where d_{zp} is publication price (unit of standard area, standard broadcast time etc.) in z mass media on p page (in p broadcast time etc.). After that, an important action is the calculation of «cost per thousand» readers:

$$e_{Z_i G_i P R_i} = \frac{d_{Z_i P}}{b_{Z_i R_i} \times c_{Z_i G_i R_i}}.$$

According to the different price in different cities (regions), the «cost per thousand» quantity will difference. So, ind index can be presented as ind_{ZGR} and matrix IND converted into cube, but in our example (11) it is necessary to leave just two indices Z and G :

$$IND_{ZP} = \begin{vmatrix} ind_{1Z} & \dots & ind_{1P} \\ \dots & \dots & \dots \\ ind_{Z1} & \dots & ind_{P1} \end{vmatrix}, \quad (11)$$

where ind_{zg} is the influence of z mass media on g -th focus group or its segment. The ratio of advantages in g -th focus group for each studied above j criteria of $p_j(k, h)$ for pair of mass media alternatives A_k, A_h can be presented as

$$p_j^g(k, h) = \begin{cases} \frac{r_{kj}^g - r_{hj}^g}{m_j}, & \text{if } r_{kj}^g > r_{hj}^g, \\ 0 & \text{if not.} \end{cases} \quad (12)$$

where m_j is the rating scale according to the j criteria, r_{kj}^g, r_{hj}^g are the value of the A_k, A_h options according to the j criteria in g -th focus group.

The ratio of advantages over a pair of alternatives (A_k, A_h) taking into account all considered criteria (12) can be defined by following expression (13):

$$p^g(k, h) = \sum_{j=1}^J p_j^g(k, h) = \sum_{j=1}^J \begin{cases} \frac{r_{kj}^g - r_{hj}^g}{m_j}, & \text{if } r_{kj}^g > r_{hj}^g; \\ 0 & \text{if not.} \end{cases} \quad (13)$$

The ratio of the dominance A_k alternative over A_h in g -th focus group can be presented by membership function (14) which characterizes the dominance intensity of k over h mass media:

$$\mu_D^g(k, h) = \begin{cases} p^g(k, h) - p^g(h, k), & \text{if } p^g(k, h) > p^g(h, k); \\ 0 & \text{if not.} \end{cases} \quad (14)$$

The best alternative using (12) – (14) corresponds to the following expression:

$$\mu^*(A_k^*) = \max_{k=1, \dots, m} D_{k=1, \dots, m} \mu^*(A_k) = 1 - \min \left\{ \max_{\substack{l=1, \dots, l \\ l \neq k}} \left[p(k, h)_{l=1, \dots, l}^{k=1, \dots, m} - p(h, k) \right] \right\}.$$

As a result of Stage 6, the mass media which according to the criteria has the highest rating will be chosen. Moreover, isn't necessarily it will be one mass media for all disposition places. It is also possible to choose different mass media for different disposition places.

3.7 Stage 7 – Selection the manipulation method

In database the manipulative influence methods (M) are stored (for example [12]). These methods (15) can be presented as following complex set:

$$M = \left\{ \bigcup_{i=1}^x M_i \right\} = \left\{ \bigcup_{i=1}^x \left\{ \bigcup_{j=1}^e M_{ij} \right\} \right\} = \{ \{M_{11}, M_{12}, \dots, M_{1e}\}, \{M_{21}, M_{22}, \dots, M_{2e}\}, \dots, \{M_{x1}, M_{x2}, \dots, M_{xe}\} \}, (i = \overline{1, x}, j = \overline{1, e}) \quad (15)$$

In database all methods are separated by certain characteristics and used by different mass media. Furthermore, each agent chooses the most effective method from the database that, in agent's opinion can use by mass media. After that, the list of criteria (16) for which the methods selecting are conducting will be formed.

$$M_j^i = (k_1 \alpha_{1,j}^i + k_2 \alpha_{2,j}^i) \times k_3 \alpha_{3,j}^i, i = \overline{1, I}, j = \overline{1, J}, \quad (16)$$

where k_l «the value» of l criteria ($l=1, 2, 3$), α_{ij}^l is criterion value of j operative manipulative influences method according to i strategy for l criteria.

As a result of Stage 7, manipulative influence methods which will be implemented by the mass media chosen in step 6 will be chosen.

3.8 Stage 8 – Estimation of manipulative influence

If the initial evaluation of g -th focus group is presented as b_g , then the task of manipulation is to change the group's opinion to

$$b_g + q_g, q_g \in Q_g, g \in N,$$

where q_g is the change of initial opinion, thus q_g is the controlling influence.

As a result of the sequence of operational manipulative influences, the final opinion in some focus groups is formed:

$$\overline{B}_q = T(\overline{b} + \overline{q}),$$

where q_g is the initial opinion of focus group, $\overline{q} = \prod_{g \in N} q_g$.

The target function of public opinion modification can be represented as follow:

$$\Phi(\overline{B}_q, \overline{q}) = \max H(\overline{B}_q) - C(\overline{q}), \quad (17)$$

where $H(\bullet)$ are received benefits (profit, votes in elections, change in certain officials or government etc.) by an organization in whose interests the manipulative influence is conducted, which depends on the change of public opinion, $C(\bullet)$ are costs for manipulative actions.

Using (17) the task of management is to choose an acceptable management method that maximizes efficiency $\Phi(\overline{B}_q, \overline{q}) \rightarrow \max$. The value of operational influence can be determined by following expression:

$$D_i = -f(\delta_i^k)(x_i^k - x_i^{k+1}),$$

where $f(\delta_i^k)$ is a function (table or algorithm), that reflects the difference in scores $x_i^k - x_i^{k+1}$ in the amount of operational influence, for example, the volume and number of compromising newspaper articles or news releases on the TV channel. If $x_i^k < x_i^{k+1}$, then $D_i = f(\delta_i^k)(x_i^{k+1} - x_i^k)$. The effectiveness l of influence E^l in period τ^k is determined in different ways (18), in particular, by the following formula:

$$E^l(\tau^k) = \begin{cases} \frac{w_l^k - w_l^{k+1}}{x_i^k - x_i^{k+1}}, & \text{if } (w_l^k > w_l^{k+1}) \vee (x_i^k > x_i^{k+1}) \\ \frac{w_l^{k+1} - w_l^k}{x_i^{k+1} - x_i^k}, & \text{if } (w_l^{k+1} > w_l^k) \vee (x_i^{k+1} > x_i^k) \end{cases}, \quad (18)$$

where w_l^k is influence assessment in the period τ^k , x_i^k are the magnitudes (levels) of the produced influence of l type in the period τ^k , $l = \overline{1, L}$ is influence type.

4 Experimental Study and Discussion

The specialized experimental technique was developed for mentioned network-centric approach and also implemented for quantitative assessment based on real examples in social media sphere. In practice the task of destructive manipulative influence causes changing opinions, views and behavior of focus groups. If primary assessment of g -th focus group is b_g , then task of destructive manipulative influence is changing to $b_g + q_g$, $q_g \in Q_g$, $g \in N$, where q_g is changing of opinion and q_g is controlling influence. As result of the sequence of manipulative influences the finishing opinion of focus group is forming. Next by using expressions (17) – (18) the effectiveness of influences can be calculated for all Internet mass media (see last stage of proposed approach). Considering the network-centric concept involves data analyzing and gathering from different regions for obtaining results on manipulative influences, it is proposed to calculate the influence of the mass media and its efficiency as an average of 3 Ukrainian regions for 4 Internet newspapers (named „Facts“, „Segodnya“, „Komsomolska Pravda“ and „Dzerkalo tyzhnia“) and 3 manipulation methods selected by experts in accordance to 7 Stage of proposed approach.

The influence of selected mass media presented in Tabs. 1, 3, 5, 7; the effectiveness of influence showed in Tabs. 2, 4, 6, 8 in accordance to (18). The value of operational influence will be determined by the number of articles (using competent expert estimation in this sphere).

Table 1. Table captions should be placed above the tables.

	x_1^0	x_1^1	x_1^2	x_1^3
	1	3	4	5
D_i	n/a	2	3	4

Table 2. Effectiveness of influence of newspaper „Facts“

	w_1^0	w_1^1	w_1^2	w_1^3
The value of influence effectiveness presented in %	18	28	34	33
E_1^{Pi}	n/a	14	11,3	9

Table 3. Manipulative influence of newspaper „Segodnya“

	x_2^0	x_2^1	x_2^2	x_2^3
	1	3	4	5
D_i	n/a	2	3	4

Table 4. Effectiveness of influence of newspaper „Segodnya“

	w_2^0	w_2^1	w_2^2	w_2^3
The value of influence effectiveness presented in %	11	14	18	20
E_2^{Pi}	n/a	7	6	5

Table 5. Manipulative influence of newspaper „Komsomolska Pravda“

	x_3^0	x_3^1	x_3^2	x_3^3
	1	3	4	5
D_i	n/a	2	3	4

Table 6. Effectiveness of influence of newspaper „Komsomolska Pravda“

	w_3^0	w_3^1	w_3^2	w_3^3
The value of influence effectiveness presented in %	9	24	28	34
E_3^{Pi}	n/a	12	9,3	8,5

Table 7. Influence of newspaper „Dzerkalo Tyzhnia“

	x_4^0	x_4^1	x_4^2	x_4^3
	1	3	4	5
D_i	n/a	2	3	4

Table 8. Effectiveness of influence of newspaper „Dzerkalo Tyzhnia“

	w_4^0	w_4^1	w_4^2	w_4^3
The value of influence effectiveness presented in %	10	20	30	40
E_4^{Pi}	n/a	10	10	10

These tables present the influence of different Internet mass media and the value of manipulative influence on public opinion.

In Fig. 1 graphically depicts the ratio of the value of operational influence, that is the number of articles, to the value of the effectiveness of manipulative influence.

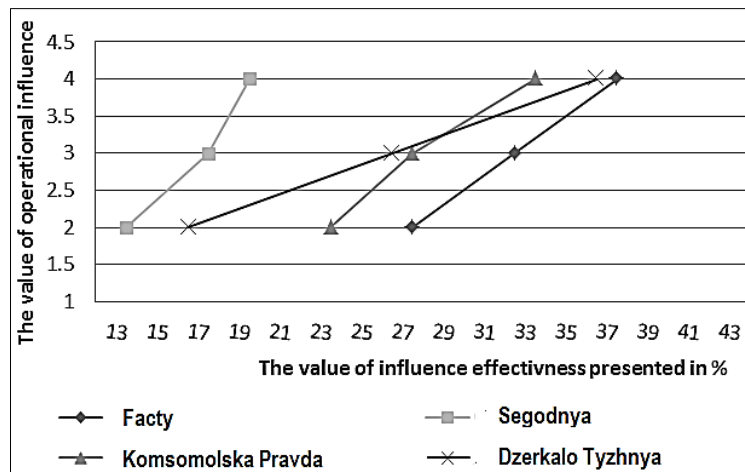


Fig. 1. Effectiveness of mass media influence on public opinion

In accordance to Fig.1 can be declared that the biggest value of destructive manipulative influence (with smallest operational influence) shows Internet mass media “Facty” – when the number of articles is 2, the effectiveness of manipulative influence is equal to 28%. For comparison another Internet mass media “Segodnya” shows the effectiveness of manipulative influence equal to 14% with the number of articles equal to 2. Experimental study has confirmed and demonstrated the developed network-centric approach ability in practical cases for effective destructive manipulative influence evaluation in social media.

5 Conclusions

In this paper the network-centric approach to destructive manipulative influence evaluation in social media was developed. This approach by means of evaluating financial expenditures, defining goals, objectives and strategies for manipulating, selecting Internet mass media and classified methods of manipulation, based on the generated databases of causes, goals of the criteria, focus groups and mass media, allows calculating the quantitative parameters that characterize the level of destructive manipulative media influences on public opinion. Experimental study confirmed this approach ability for quantity manipulative influence evaluation which realized by modern mass media and using manipulation influence methods on personal or public opinion. Given results will be useful in information security for evaluation harmful mass media influence on public opinion or on consciousness individuals. In the next research, it is going to conduct an experimental study of the developed method for its verification,

correctness confirmation, as well as the establishment of the practical application possibility for raising the information and psychological security level of citizens, society and the state in cyberspace (for example it will be very actual and important in critical information infrastructure of the state [13]). Also using this approach specialized software tools can be developed for manipulative influence automatized detection and quantitative evaluation.

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