

# Predictive Online Analysis of Social Transformations based on the Assessment of Dissimilarities between Government Actions and Society's Expectations

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**Abstract**— The methodology for assessing the effectiveness of social transformations has been developed, which is based on determining the degree of inconsistency between government actions and expectations of the society, and the synergy (social activity) of people, depending on the above-mentioned degree of inconsistency. A set of tools and services has been developed to quantify the parameters and characteristics of social transformations within the Advanced Analytics integrated online platform. These tools allow us to monitor open online publications and social networks on the basis of linguistic sentiment analysis of a large number of messages. The effectiveness of the proposed methodology, tools and services of the Advanced Analytics online platform was proved using the example of quantitative assessment of Ukraine's population attitude to actions of the authorities related to the strengthening of quarantine measures aimed at counteracting the spread of the COVID-19 pandemic.

**Keywords**— vector of government actions, vector of society's expectations, vector of transformations (reforms), linguistic sentiment analysis of Internet media data and social networks, open source intelligence, Advanced Analytics online platform

## I. GENERAL APPROACH TO ASSESSMENT OF SOCIAL TRANSFORMATIONS EFFICIENCY

Let's assume that social transformations (reforms)  $|\vec{R}|$  will be insofar effective as the direction of the vector of expectations and social activity  $\vec{S}$  is closer to the vector of government action  $\vec{G}$  and the synergy of society is higher. The synergy of society is understood as additional social activity (social energy), which is created by the interaction of citizens and may be positive when the society realizes that successes generate new successes, and negative when failures result in loss of people's hope for positive change (apathy) and, consequently, generate new failures.

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Let  $\alpha$  be the angle between vectors  $\vec{S}$  and  $\vec{G}$ , and  $K_s$  – coefficient of the synergy of society. As a rule, the synergy of society is a nonlinear characteristic of the angle  $\alpha$ . The limit values of angle  $\alpha$  are  $\alpha = 0$ , when the directions of the aforesaid two vectors coincide (maximum social transformations and maximum synergy of society is observed), and  $\alpha = 180$ , when their directions are opposite (absence of any social transformations, negative social energy is created and a revolutionary state of society emerges).

Note that for different states of society, which can vary from fatigue and apathy to social uplift and optimism, the synergy coefficient of society  $K_s$  may have different values. In our study we shall consider the following set of values of the synergy coefficient of society  $K_s = [0.25; 0.5; 0.75; 1.0]$ .

Note that at  $\alpha = 90$  the vector of government action and the vector of social activity (expectations) of society will be orthogonal. It means that at  $\alpha = 90$  the government and society will act independently of one another.

To define a norm of resultant vector  $|\vec{R}|$  (social transformation vector), which complies with the scope of social transformations, we can use the model proposed by the authors in [1]:

$$|\vec{R}| = |\vec{G}| + |\vec{S}| \cos \alpha + K_s (|\vec{G}| + |\vec{S}|)^2 \cos \alpha; \quad (1)$$
$$\alpha \in [0, 180].$$

In this model, the assessment of  $|\vec{R}|$  vector norm is made both by expert and qualitative methods, or by the two methods together.

In order to make quantitative assessment of the norm of the vector of social transformations  $|\vec{R}|$  (scope of reforms) and

the angle  $\alpha$  (as a measure of inconsistency between government actions and society's expectations), it is proposed to use the methods of sentiment analysis of information messages received from online media and social networks.

To assess the scope of social transformation by the expert method we shall use the Miller's scale (1, ..., 7). For example, choose the value 0.5 as a sampling interval of the Miller's scale. The value 7 of the Miller's scale corresponds to the full support of the government actions by the society, and the value of 1 means that the society does not fully support the government actions.

Let's transform the value of the Miller's scale into the value of the angle of deviation of the vector of government actions  $\vec{G}$  and into the value of the norm of the vector of social transformations  $|\vec{R}|$  for different values of the coefficient of synergy of the society  $K_s$  according to the computation table (Table I).

Example: Assume that experts assessed five values of the angle of deviation for the given two vectors  $\vec{S}$  and  $\vec{G}$  using the following points: a) 7 ( $\alpha = 0$ ); b) 5.5 ( $\alpha = 45$ ); c) 4 ( $\alpha = 90$ ); d) 2.5 ( $\alpha = 135$ ); e) 1 ( $\alpha = 180$ ). Then, using  $K_s = 0.5$  from the mapping table (Table 1) we get (Fig. 1): a)  $\alpha = 0$ ;  $|\vec{R}| = 4$  – maximum social transformations; b)  $\alpha = 45$ ;  $|\vec{R}| = 3.121$  – high social transformations; c)  $\alpha = 90$ ;  $|\vec{R}| = 1$  – society and authorities act independently of each other, the state of social apathy; d)  $\alpha = 135$ ;  $|\vec{R}| = -1.121$  – economic stagnation, long-term recession of social and economic characteristics of the society; e)  $\alpha = 180$ ;  $|\vec{R}| = -2$  – critical state of social and economic characteristics of the society, a revolutionary situation emerges in a country.

TABLE I. ASSESSMENT OF SOCIAL TRANSFORMATIONS EFFICIENCY

Miller's scale	Angle of deviation $\alpha$	Norm of $\vec{R}$ vector			
		$K_s = 0.25$	$K_s = 0.5$	$K_s = 0.75$	$K_s = 1.0$
7	0	3.000	4.000	5.000	6.000
6.5	15	2.932	3.898	4.864	5.830
6	30	2.732	3.598	4.464	5.330
5.5	45	2.414	3.121	3.828	4.536
5	60	2.000	2.500	3.000	3.500
4.5	75	1.518	1.776	2.035	2.294
4	90	1.000	1.000	1.000	1.000
3.5	105	0.482	0.224	-0.035	-0.294
3	120	0.000	-0.500	-1.000	-1.500
2.5	135	-0.414	-1.121	-1.828	-2.536
2	150	-0.732	-1.598	-2.464	-3.330
1.5	165	-0.932	-1.898	-2.864	-3.830
1	180	-1.000	-2.000	-3.000	-4.000

## II. METHODS AND TOOLS OF INTERNET MEDIA DATA AND SOCIAL NETWORKS ANALYSIS

A significant amount of information resources in global networks contains people's opinions and their expert assessments. Information extracted from documents exposed in open sources can be analyzed, summarized, and used as a basis for further implementation. These data differ from traditional expert assessments both in terms of scope and level of objectivity. Statistically, 30%-40% of information related

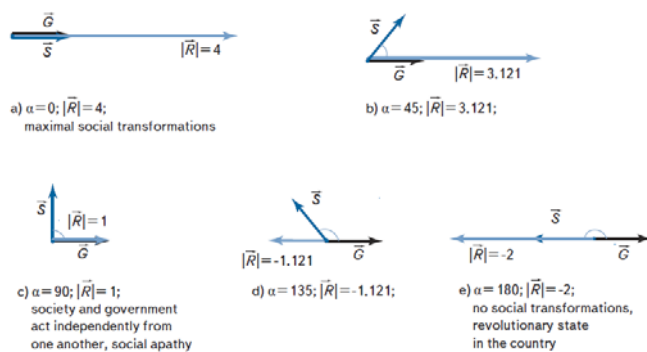


Fig. 1. Social transformations efficiency (scope of reforms)

to the reaction of network users to the activities of public authorities is accumulated in social networks.

Hence, analysis of information from web resources should be essential in the sphere of public administration as one of the feedback channels.

In the field of security and defense, this line of the media scene study is called "open source intelligence" (Open Source Intelligence, OSINT). This line of study includes the search, collection and analysis of intelligence information obtained from publicly available open sources [2, 3] and formation of reports on the object of observation.

Today, public administration is one of the important areas of application of Open Source Intelligence technologies, OSINT. The efficiency of legislative drafts and government decisions, on the whole, is reflected in the public opinion regarding the government actions, whose indicator may be, in particular, the number of news publications on relevant topics in the media scene. Concurrently, forecasting and predicting future events is one of the integral components of the OSINT [4].

On the basis of this approach, a modern information system of social media monitoring and analysis is built, which is based on the concept of Big Data processing, Complex Networks research, Text Mining, Information Extraction. The system provides for the use of search engine components (Elasticsearch, Sphinx search, InfoStream, etc.), graph DBMS Neo4j, Gephi type.

The principal idea of such a system of intelligent analysis of Big Data from social media is the simultaneous use of methods and means of information retrieval, analysis and aggregation of data from modern information flows.

The system provides automatic scanning and primary processing of information from websites, social networks, messengers. Messages are used from the following social media: Twitter, Youtube, Rutube, Telegram, Facebook, Reddit, Medium, Instagram, LiveJournal, etc., a number of websites, which are formed by special software modules that are the parts of the system. Based on this, full-text databases are created, information messages similar in content are detected, and a full-text search is performed. The concepts are extracted and linguistic content analysis of text messages is performed, the sentiment analysis on the basis of neural networks use and machine learning. Data analysis and visualization are performed, studies of dynamics of thematic information flows are carried out; forecasting and prediction is made basing on the analysis of the dynamics of publications in social media.

In order to apply forecasting mathematical methods and predict consequences of social transformations, time series are formed that correspond to the volume of publications in social media over certain intervals of time. The emotional polarity of publications is of paramount importance when performing content analysis [5].

*Sentiment Polarity* is the emotional attitude of the author of a narrative to some object, which is expressed in the text. The emotional component, expressed at the level of a lexical item or communicative fragment, is called a polarity (or lexical sentiment). The polarity of the entire text as a whole may be defined as a function (in the simplest case, the sum) of the polarities of its constituent units (sentences) and rules of their combination [6].

In particular, time series of messages of positive and negative sentiments are used in this system, whose values correspond to the daily number of publications of the respective polarity.

The method of determining the polarity is used in the system, and based on the application of statistical patterns associated with the presence of certain lexical items in texts, the naive Bayesian approach and the method of neural networks [7]. The distinctive feature of the method is its relative simplicity and universality, while the accuracy of the estimate can be adjusted parametrically within a fairly wide range.

In the case of assessing messages polarity, the hypothesis space will contain:  $H_{-1}$  – negative sentiment,  $H_0$  – neutral sentiment and  $H_1$  – positive sentiment. For the sake of simplicity, let us consider events of the following type:  $H_1$  – positive sentiment,  $H_{-1}$  – non-positive sentiment. It is assumed that those particular words are selected for the document collection with the positive sentiment, which are peculiar to these documents. The words  $t$  with values of  $p(t|H_1)$  exceeding  $1/2$ , for example 0.6, are chosen from among them. Such words carry evaluative semantics (polarity).

In order to simplify the model, it is assumed that for all selected polarized terms the weight is the same, equal to  $\alpha$  (may vary when training the model). Then the following formula is used to estimate the positive polarity [6]:

$$S(x) = \frac{\alpha^x}{\alpha^x + \lambda(1 - \alpha)^x}, \quad (2)$$

here  $x$  is the number of words in the information message that are important from the standpoint of positive polarity,  $\alpha$  is the weight,  $\lambda$  is a constant that reflects the state of messages of positive and negative polarity (in the naive model  $\lambda = 1$ ).

In order to evaluate the hypothesis for the negative polarity of the message ( $H_{-1}$ ), the glossary may be used, which consists of words with the “negative sentiment”, on the basis of formula (2). However, the decision on the polarity of the message shall be made with due account for the difference between the values of the weight estimates of hypotheses  $H_1$  and  $H_{-1}$ . The threshold value of  $\alpha$  in this case is also determined in the course of setting up (training) the system.

### III. DETERMINATION OF THE VECTOR OF SOCIAL ACTIVITY OF THE SOCIETY

The vector of social activity will be considered as:

$$\vec{S} = \vec{S}_{-} + \vec{S}_{=} + \vec{S}_{+},$$

here  $\vec{S}_{-}$  is a component of the negative attitude (actions), which corresponds to the opposition of society to the actions of the authorities;  $\vec{S}_{=}$  is a neutral component, which corresponds to the neutral attitude of society to the actions of the authorities;  $\vec{S}_{+}$  is a positive component that corresponds to the approval (support) of government actions by the society.

According to this definition, vectors  $\vec{S}_{-}$  and  $\vec{S}_{+}$  are collinear to the vector of government actions  $\vec{G}$  (the directions of vectors  $\vec{S}_{+}$  and  $\vec{G}$  coincide, while the directions of vectors  $\vec{S}_{-}$  and  $\vec{G}$  are opposite), and vector  $\vec{S}_{=}$  is orthogonal to the vector  $\vec{G}$ . If we choose the orthogonal basis so that the condition  $\vec{G} = (0,1)$  should be met, then the following formulas may be written:

$$\vec{S}_{-} = (-|\vec{S}_{-}|, 0), \vec{S}_{=} = (0, |\vec{S}_{=}|), \vec{S}_{+} = (|\vec{S}_{+}|, 0),$$

$$\vec{S} = (|\vec{S}_{+}| - |\vec{S}_{-}|, |\vec{S}_{=}|),$$

$$|\vec{S}| = \sqrt{(|\vec{S}_{+}| - |\vec{S}_{-}|)^2 + |\vec{S}_{=}|^2},$$

$$\cos \alpha = \frac{|\vec{S}_{+}| - |\vec{S}_{-}|}{|\vec{S}|}, \alpha \in [0, 180]. \quad (3)$$

Let's assume that the social activity of the society is reflected in the flow of messages of various media resources and social networks, and the sentiment polarity of these messages corresponds to the attitude (actions) of certain individuals and (or) social groups to given events, including those that result from the government activity.

If we get a selected sample of messages:

$$M = M_{-} \cup M_{=} \cup M_{+}, M_i \cap M_j = \emptyset,$$

$$i, j \in \{-, =, +\}, i \neq j,$$

here  $\{-, =, +\}$  is negative, neutral and positive polarity of messages, then the following formulas take place:

$$|\vec{S}_{-}| \sim |M_{-}| \sim p_{-} = \frac{|M_{-}|}{|M|},$$

$$|\vec{S}_{=}| \sim |M_{=}| \sim p_{=} = \frac{|M_{=}|}{|M|}, \quad (4)$$

$$|\vec{S}_{+}| \sim |M_{+}| \sim p_{+} = \frac{|M_{+}|}{|M|},$$

here  $p_i, i \in \{-, =, +\}$  is the proportion of messages with negative, neutral and positive polarity, respectively. In view of (4) we get the estimate:

$$|\vec{S}| \sim \sqrt{(p_{+} - p_{-})^2 + p_{=}^2}, \quad (5)$$

We shall use formulas (3) – (5) in model (1), and the obtained quantitative estimate of the norm of vector of social transformations  $|\vec{R}|$ , reduced to the range (1, ..., 7) in accordance with the values of Miller scale (Table I) shall be used in order to verify the consistency of quantitative and expert assessments of:



- the norm of the vector of social transformations  $|\vec{R}|$  (scope of reforms);
- angle  $\alpha$  (as a measure of inconsistency between government actions and society's expectations).

Consider the cases when  $p_+ = p_-$ ,  $\cos \alpha = 0$ .

When  $p_- = 1$ , the whole set of messages has neutral polarity. When  $p_+ = p_- = 0.5, p_+ = 0$ , we observe the maximum polarization of opinions in the society concerning government actions, but in both cases  $|\vec{R}| = 1$ .

In order to distinguish these states, we define the coefficient of conflict as:

$$C = -(p_+ + p_-) \frac{c_+ \log c_+ + c_- \log c_-}{\log 2},$$

$$\text{here } c_+ = \frac{p_+}{p_+ + p_-}, c_- = \frac{p_-}{p_+ + p_-}.$$

The conflict coefficient  $C$  is a weighted entropy, its values lie within the range  $[0,1]$ . The state  $p_+ = p_- = 0.5, p_+ = 0$  corresponds to the value of  $C = 1$ .

#### IV. ADVANCED ANALYTICS ONLINE PLATFORM FOR EVALUATION OF SOCIETY'S ATTITUDE TOWARD GOVERNMENT ACTIONS

The proposed method was used to implement a specialized application of the Social BI class [8], developed in the form of a dashboard using the tools and services of the Advanced Analytics online platform of the World Data Center for Geoinformatics and Sustainable Development (WDC-Ukraine) [9].

This integration platform is a distributed information system that includes services for the development and publication of single-page applications (SPA), data management and processing services, automatic Big Data collection and Data Mining services. The specific feature of the system is the use of such integration tools developed by the World Data Center for Geoinformatics and Sustainable Development, which allows users to combine a variety of heterogeneous resources and services within a single IT infrastructure [10, 11].

Thus, in the process of implementing the application in order to assess society's attitude to government actions based on the analysis of data from Internet media and social networks (SPA "PRO ET CONTRA"), the following components of the online platform were used:

- System of Development and Publication of One-Page Applications (SPA Host);
- Data Processing Service;
- System of Media Sources Monitoring and Analysis of Big Data from Media ("Robusta").

The scheme of interaction of the online platform components is shown in Fig. 2.

Overall view of dashboards is shown in Fig. 3-5.

#### V. PRACTICAL APPLICATION OF THE ADVANCED ANALYTICS ONLINE PLATFORM IN THE CONTEXT OF COVID-19 SPREAD

Findings from the analysis of public attitude to government actions related to escalation of quarantine measures caused by COVID-19 pandemic spread are given

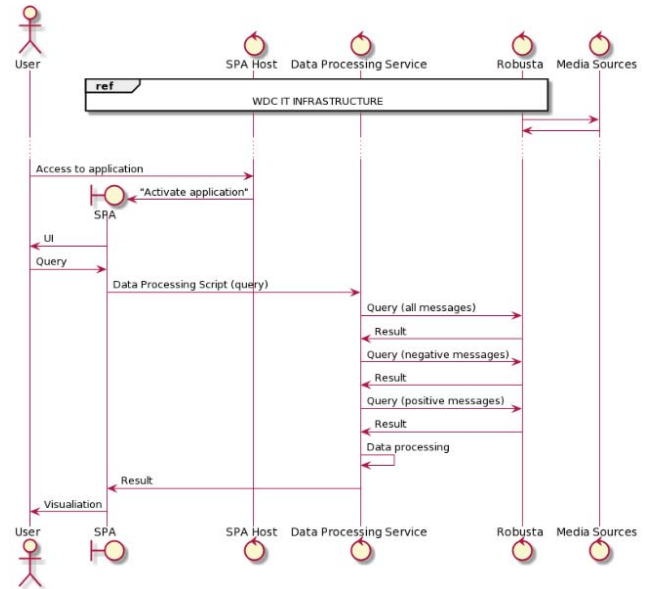


Fig. 2. Sequence Diagram of WDC-Ukraine Advanced Analytics online platform components' collaboration for SPA "PRO ET CONTRA" request processing

below. These results were obtained using the developed application "PRO ET CONTRA" for the test data set of the Robusta system, which were collected over 200 days from the most popular 11 social media and 100 Ukrainian news websites (sample size is over 2 million messages).

The request was generated in the language of the Robusta system:

*("ужесточен карантин"|" посилен карантин")  
(україн|украин),*

which selects messages in both Ukrainian and Russian languages whose text includes phrases "quarantine escalation" (Russian: «ужесточение карантина» or Ukrainian: «посилення карантину») in various grammatical cases and genders, and the words that begin with "Ukrain" (Russian: «украин» or Ukrainian: «україн») (letter case does not matter).

Fig. 3 shows the dashboard of main results of the analysis, which demonstrates that 913 messages were selected within the period from 2020/03/12 to 2020/08/08. Of these, 579 are negative, 294 are neutral, and 40 are positive (as a decimal

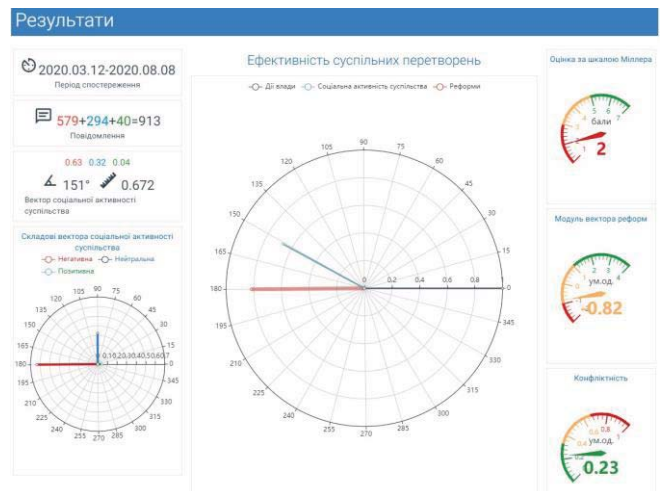


Fig. 3. Main Analysis Results Dashboard

quantity this is 0.60, 0.32, and 0.04, respectively). The proportion between these messages is shown in the vector diagram given below. From these data the estimates of the norm of vector of social activity of the society  $|\vec{S}| = 0.672$  and  $\alpha = 151^\circ$  were calculated. The vector diagram which is given in the center of the dashboard, shows the proportion between the vectors of government actions  $\vec{G}$ , social activity (expectations) of the society  $\vec{S}$  and the vector of reforms  $\vec{R}$ .

The results of the analysis indicate that the attitude of the society to the actions of the authorities related to the quarantine measures escalation is quite consolidated (conflict coefficient  $C = 0.23$ ) and substantively negative (Miller's score  $-2$  points), hence, the opposition to actions of the authorities ( $|\vec{R}| = -0.82$ ) emerges in the form of ignoring quarantine restrictions.

Fig. 4 represents a dashboard for analyzing the dynamics of the flow of messages. It shows the instantaneous (left) and integral (right) numbers of messages and their Miller's score.

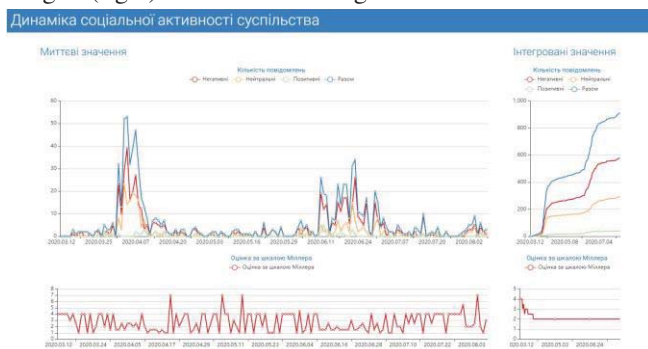


Fig. 4. Message Flow Analysis Dashboard

As can be seen from Fig. 4, there are two peaks of revival of social activity of the society:

- *The first peak* (2020/04/01 – 2020/04/10) is associated with imposition of the emergency state and restrictive quarantine measures. On March 25, the emergency state was announced throughout Ukraine; quarantine was extended until April 24, trade facilities were closed, except for grocery stores, pharmacies, motorway filling stations and banks. Metro transportation activity was suspended in Kyiv, Kharkiv and Dnipro, intercity and interregional automobile, railway and air transportation was also suspended. On April 2, the government passed a resolution to tighten "quarantine" restrictions. On April 6, new restrictive quarantine measures were introduced in Ukraine: a ban on visiting parks and recreation areas, mandatory wearing of face masks in public places, and people over 60 were recommended to stay at home.
- *The second peak* (2020/06/11 – 2020/06/30) is associated with a significant deterioration of the epidemic situation in Ukraine and the continuation of adaptive quarantine. On June 11, due to a significant deterioration of the epidemic situation in Ukraine, the Ministry of Health resorted to quarantine escalation. In particular, restrictions on entry to Ukraine for foreigners were tightened (insurance policy is needed). On June 12, there was information of the Government's plans to abolish the principal

external independent testing (EIE) for applicants entering higher education institutions in 2020.

Later, the Ministry of Health published three scenarios for conducting the EIE in 2020: to conduct this test within the predetermined period, from June 25 to July 17, or change the dates, or cancel the test at all.

On June 17, the Government decided to extend the adaptive quarantine until July 31 with updated rules for its observance. On June 22, mass inspections were initiated by the National Police for compliance with quarantine rules in stores, catering establishments, consumer services, and transport facilities. New criteria for easing / escalating quarantine measures in the regions have also come into force.

Fig. 5 shows the widgets for analyzing the dynamics of the reform vector and the proneness to conflict.

As one can see from Fig. 5, the values of the reform vector modulus are close to zero throughout the observation period (see average values for 1 week). It means that the level of public disapproval of government actions is high, which makes these actions ineffective.

From the diagram of the proneness to conflict dynamics (Fig. 5), we see that the periods which correspond to the previous peaks of activity are characterized by less consolidated attitude of the society towards the government actions (availability of discussion).

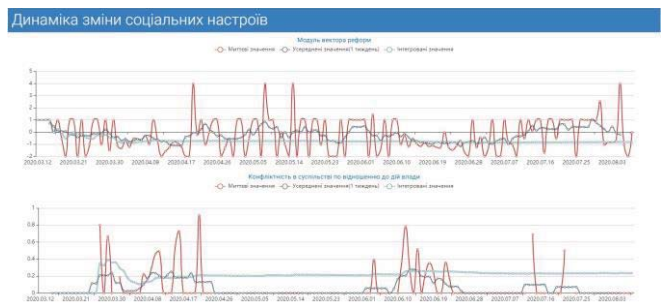


Fig. 5. Widgets for analysis of dynamics of reforms vector and conflict

## VI. CONCLUSIONS

1. A methodology for evaluating the efficiency of social transformations has been developed; it is based on determining the degree of inconsistency between government actions and expectations of the society, and the synergy (social activity) of persons, depending on the aforesaid degree of inconsistency.

2. According to the above-mentioned methodology, the results of monitoring of open online publications and social networks on the basis of the sentiment analysis of a large number of messages are used as initial data for quantitative calculations of parameters and characteristics of social transformations.

3. Basing on the integration of various heterogeneous resources and services within a single IT infrastructure:

- the Advanced Analytics on-line platform of the World Data Center for Geoinformatics and Sustainable Development, which includes services for the development and publication of single-page

applications (SPA), data management and processing services, automatic Big Data collection and Data Mining services; and

- specialized application “PRO ET CONTRA” of the Social BI class in the form of a dashboard is developed;
- request processing in the Robusta system of Media Sources Monitoring and Analysis of Big Data from Media, is improved.

4. The efficiency of the proposed methodology, tools and services of the developed Advanced Analytics online platform was demonstrated through the quantitative assessment of the Ukrainian population’s attitude toward the government actions associated with the escalation of quarantine measures caused by COVID-19 pandemic spread.

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