

Determining the Required Number of Information Channels Based on the Information Dissemination Model

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Abstract

The article considers issues related to the study of processes that characterize the dissemination of information materials, as well as analysis of qualitative characteristics of information to assess the potential coverage of target audiences and the degree of perception of this information by the relevant audience.

The purpose of the article is to develop an analytical model for determining the required number of tools (information channels) to achieve certain goals in the implementation of the strategic narrative of the state, taking into account the requirements that affect the dissemination of information.

The application of the proposed mathematical tools to determine the required number of tools (information channels) in the interests of implementing the strategic narrative of the state on the basis of analytical model of information dissemination, will reasonably form the need and volume of information and psychological impact on target audiences. , and the quality of news channels. This will provide an opportunity to identify the main tasks for the system of strategic communications and to realize the interests of the state in the form of public support for the strategic course of the state to gain full membership of Ukraine in the EU.

Keywords

Target audience, narrative, dissemination of information, strategic communications

1. Introduction

Ukraine's integration into the Euro-Atlantic security space and the acquisition of NATO membership have been identified as the main goal of Ukraine's Military Security Strategy, which was enacted by the Decree of the President of Ukraine in March 2021. To achieve this goal, Ukraine will take a set of appropriate measures. One such measure is countering in cyberspace and imposing one's will in the information space [1].

To organize the implementation of such a task,

it is necessary to have an effective and efficient system of strategic communications of the state, which uses a single information space, has reliable channels of communication with the population and an appropriate branched information infrastructure.

2. General Problem Statement

In previous publications, the authors solved the problem of scientific substantiation of accession to the EU, NATO on the basis of analysis of

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statistical data of public opinion and forecasting scenarios for its development [2, 3].

The obtained forecast data allowed to determine the peculiarities of the implementation of the strategic narrative of the state by the system of strategic communications and to realize the interests of the state in the form of public support for its strategic course to Ukraine's full membership in the EU and NATO. The proposed approach will allow to develop effective and efficient materials of information and psychological impact, which will be implemented by a system of strategic communications when influencing the relevant target audiences. An extremely important task will be to study the processes that characterize the distribution of information materials, as well as the analysis of qualitative characteristics of information to assess the potential coverage of target audiences and the degree of perception of this information by the relevant audience. This article is devoted to the statement of a possible variant of the decision of the resulted problems.

2.1. Analysis of recent research and publications

The armed aggression of the Russian Federation against Ukraine is carried out in various directions of the "hybrid war". Aggressive influences are carried out both simultaneously and consistently, practically on all spheres of life of the state, thus the received results in one sphere are at once used for strengthening of influence in other spheres. To date, a large number of domestic and foreign scientists are engaged in research on "hybrid actions". In the works of Landa D.V., Danyka Y.G., Salnikova O.F., Snitsarenko P.M. and many others, covers materials on the forms and methods used by the aggressor to achieve its imperial goals, and contains a number of theoretical provisions, recommendations on possible ways to counter. Unfortunately, scientific publications on the mathematical justification of the necessary forces and means, in achieving specific goals, are not enough.

A number of software services are available on the Internet, with which it is possible to simulate the process of information dissemination. The authors with the help of one of such services (Melting Asphalt) visualized a model of information dissemination among the target audience [4]. Indicators that influence the dissemination of information among target

audiences are proposed, and a visualization of the information dissemination model is developed [5].

The purpose of the article is the development of an analytical model for determining the required number of tools (information channels) to achieve certain goals in the implementation of the strategic narrative of the state, taking into account the requirements that affect the process of dissemination of information.

2.1.1. Research results

Today, along with Ukraine, there are several states and their associations, more powerful than Ukraine, which have interests different from the national interests of Ukraine, and Ukraine is not able to resist their aggressive actions alone. Therefore, joining NATO is one of the government's priorities in order to protect national interests.

Public opinion gained very drastic changes in the direction of European and North Atlantic cooperation with the beginning of the armed aggression of the Russian Federation. Unfortunately, during the war, Ukrainian society did not get the desired result in terms of proper support and national security of Ukraine from the EU and NATO. Starting in 2017, the number of supporters of such integration began to gradually decrease.

Public opinion on EU accession has changed somewhat depending on the political, military and economic processes that have taken place in Ukraine over the past two decades. To achieve the stated goal of the study, it is not enough for us to assess only the current distribution of public opinion on this issue. It is necessary to identify the general trends of its change in the future, to choose those that are directed in the desired direction for us and are characterized by the greatest reliability. This was achieved using scientific forecasting, namely the method of statistical extrapolation. The analysis of the obtained results shows that in order to ensure further positive forecast development of public opinion of the population of Ukraine on EU accession it is necessary in 2022 and 2023 to increase the number of supporters of society in this direction by 2.4 million people, respectively. (6.3%) in 2022 and 0.7 million people. (2.1%) in 2023 [2].

The obtained forecast data provided an opportunity to determine the peculiarities of the

implementation of the strategic narrative of the state by the system of strategic communications and to realize the interests of the state in the form of public support for its strategic course to Ukraine's full membership in the EU and NATO. An extremely important task will be to study the processes that characterize the distribution of information materials, as well as the analysis of qualitative characteristics of information to assess the potential coverage of target audiences and the degree of perception of this information by the relevant audience. In order to calculate the required number of information channels that will be used in the implementation of the strategic narrative of the state, it is necessary to calculate the corresponding need for such means of influence on the relevant target audiences. This article is devoted to the statement of a possible variant of the decision of the resulted problems.

It is known that such problems are solved on the basis of modern scientific methods of social research theory and information theory. However, recently, research methods have been used, which are based on the similarity of the processes of dissemination of information on social networks and the processes of epidemics [6 – 9]. Therefore, the process of disseminating information on social networks and viral disease can be analytically formalized using the same system of differential equations. This system of differential equations is a mathematical model of the process of information dissemination (viral disease) and can be used to optimize the processes of increasing the potential coverage of the target audience, as well as identifying qualitative characteristics of information that affects the perception of the target audience. This makes it possible to predict the reactions of target audiences to a particular information, i.e., provides an opportunity to develop strategies to improve the efficiency of working with the information product, which is provided to the target audience for its wider coverage.

Let's move on to a direct consideration of the analytical model of information dissemination. This model can be represented as the following system of differential equations [10 -12]:

$$\begin{cases} \frac{dA}{dt} = -A(t)\mu + B(t)\xi + C(t)\xi\lambda; \\ \frac{dB}{dt} = -B(t)\mu - B(t)\xi + C(t)\lambda(1 - \xi); \\ \frac{dC}{dt} = (A(t) + B(t))\mu - C(t)\lambda. \end{cases}$$

where A – the number of active subscribers to the news channel, i.e., those who read the news;

B – the number of inactive subscribers to the channel, i.e. those who have not read the news, but are subscribers;

C – the number of non-subscribers who did not read the news;

λ – the intensity of subscribing to a news agent;

μ – the intensity of unsubscribing from the news agent;

ξ – intensity of reading the news.

With the initial conditions at the time $t = 0$:

$$A(0) = A_0, B(0) = B_0, C(0) = C_0.$$

$$A_0 > 0, B_0 > 0, C_0 > 0.$$

The solution of this system of equations can be presented as follows:

$$\begin{aligned} A(t) &= C_1 g + C_2 v e^{t(-\mu-\lambda)} - C_3 e^{t(-\mu-\xi)}, \\ B(t) &= -C_1 r - C_2 u e^{t(-\mu-\lambda)} + C_3 e^{t(-\mu-\xi)}, \\ C(t) &= C_1 + C_2 e^{t(-\mu-\lambda)}, \end{aligned}$$

$$\begin{aligned} \text{where } C_1 &= \frac{A_0 + B_0 + C_0 u - C_0 v}{g - r + u - v}, \\ C_2 &= \frac{-A_0 - B_0 + C_0 g - C_0 r}{g - r + u - v}, \\ C_3 &= \frac{A_0 r - A_0 u + B_0 g - B_0 v + C_0 g u - C_0 r u}{g - r + u - v}, \end{aligned}$$

$$\begin{aligned} \text{where } g &= \left[\frac{\lambda \xi}{\mu} - \frac{\xi(-\lambda \xi + \lambda)}{\mu(-\mu - \xi)} \right], \\ v &= \left[-\xi + \frac{\xi(-\lambda \xi + \lambda)}{\lambda(\lambda - \xi)} \right], \\ r &= \frac{(-\lambda \xi + \lambda)}{-\mu - \xi}, \\ u &= \frac{(-\lambda \xi + \lambda)}{\lambda - \xi}. \end{aligned}$$

Data on the quantitative values of the first two parameters can be obtained by monitoring the news agent and the number of his subscribers. Parameter ξ takes into account such properties of the news as the relevance and timing of publication, as well as the activity of interaction of subscribers in the internal networks of the news agent.

Relevance of the news φ we will interpret as the probability of meeting the selected news in all the sources under consideration. That is

$$\varphi = \frac{m}{M},$$

where m – the number of news sources that describe the selected news;

M – total number of sources.

A parameter that characterizes the time of publication of the news δ визначається наступним чином:

$$\delta = \frac{e}{E},$$

where e – the amount of news on a particular topic, which includes controlled news, located in the user's news feed above the control news;

E – the total amount of news on a specific topic in the user's news feed.

The next parameter ω characterizes the probability of users to influence the process of increasing the readability of news. Let's assume that

$$\omega = \frac{S}{(A_0 + B_0)},$$

where S – the number of users who performed one of the actions: like or repost;

$(A_0 + B_0)$ – number of news agent subscribers.

Thus, the probability of reading the news can be given by the following expression:

$$\xi = \varphi\delta\omega.$$

Based on the above, we can conclude that if all the considered parameters of the model are known, then the values of the function can be calculated $A(t)$ at the right time and built a schedule

of growth in the number of subscribers for the specified time of the study.

The study separately assessed the impact on the growth of the number of news channel subscribers under the following initial conditions of the study: information and technical capacity of the news channel (its ability to provide news information to a given population of the study region), socio-political characteristics of target audiences. as well as the level of popularity of the selected news channel among the population (skill, professionalism of the authors of the news, the relevance of the news, the time of its publication). For each of these initial conditions of the study, three variants of news channels were selected, for which the values of all necessary parameters of the Table 1 model were calculated.

Table 1

Parameters of the analytical model of information dissemination

No	Parameter	A_0	B_0	C_0	λ	μ	φ	δ	ω	ξ	σ	ν	r	u	C_1	C_2	C_3
Version 1	Parameter value	5500	1500000	1300000	0,00135	0,000645	0,90	0,85	0,00399	0,0030	1,714	-1,808	-0,367	-0,812	910081	389925	1003817
	Equation	$A(t) = 1559879 + 707984e^{-0,002t} - 1003817e^{-0,00365t}$															
Version 2	Parameter value	3000	850000	800000	0,00135	0,00064	0,90	0,85	0,00399	0,0030	1,714	-1,808	-0,367	-0,812	536171	263828	534032
	Equation	$A(t) = 918997 + 477001e^{-0,002t} - 534032e^{-0,00365t}$															
Version 3	Parameter value	1850	515000	485000	0,00135	0,000645	0,90	0,85	0,00399	0,0030	1,714	-1,808	-0,367	-0,812	324962	160017	323404
	Equation	$A(t) = 556985 + 289310e^{-0,002t} - 323404e^{-0,00365t}$															

So, in fig. 1 shows the results of information dissemination for three information channels of different capacity, able to bring information news to regions with a population of 2.80, 1.65 and 1.00 million people, respectively. It should be emphasized that in order to identify the impact of the information capacity of the channel on the growth of its active subscribers, other parameters of the analytical model for all three news channels under consideration were chosen to be the same.

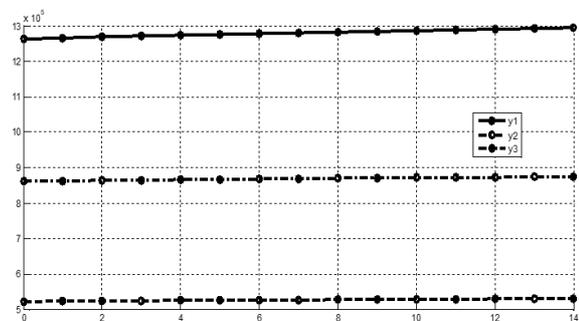


Figure 1: Graphs of growth of the number of subscribers of the news channel according to the information capacity of the channel

The analysis of the obtained results shows that the growth rate of active subscribers of the news channel depends on the number of researched target audiences. This is absolutely self-evident and logically justified. But the growth of the number of active subscribers significantly depends on the relevance of information news, political, economic, social orientation of the information message, professional skills of its presentation, as well as the level of rating authority of the information channel of its energy capacity and information capacity to disseminate news. It is clear that these characteristics of the information channel always have certain limitations. That is why in order to achieve the success of the information impact, it is necessary to assess in advance the capabilities of each available information channel on the capabilities of its information impact on the growth of the channel's active subscribers from the total population. Based on the results of these calculations, it is possible to determine the required number of information channels of different information capacity, for example, to achieve the planned positive forecast development of public opinion of the population of Ukraine on accession to the EU.

Thus, from the analysis of the results obtained with the help of the considered analytical model of information dissemination, we can conclude that for the studied period of time (two weeks), for the considered variants of the studied population the increase of active subscribers will increase by:

$1294500 - 1264000 = 30500$ new active subscribers – for option 1;

$875400 - 861970 = 13430$ new active subscribers – for option 2;

$531010 - 522890 = 8120$ new active subscribers – for option 3.

That is, with the use of the considered information channels of the corresponding information and technical capacity for the given variants of quantitative groups of the population the growth of the number of active subscribers during the year can increase accordingly by:

$30500 * 2 * 12 = 732000$ new subscribers;

$13430 * 2 * 12 = 322320$ new subscribers;

$8120 * 2 * 12 = 194880$ new subscribers.

According to the forecast [2] to ensure the desired trends in public opinion in Ukraine, we need to increase the number of supporters of European integration during 2022-2023 by at least 3.1 million citizens. That is, based on the capabilities of one information channel, it is

possible to estimate the required number of such channels to obtain the desired result of information impact on public opinion, taking into account the population of the studied regions, as well as the popularity of the selected information channel in the area. Thus, to realize the projected increase in supporters of European integration over the next two years through the information impact of channels with information capacity and capacity, corresponding to options 1-3, it is necessary at least:

3100000: 732000 \approx 5 information channels with the capacity of option 1;

3100000: 322320 \approx 10 information channels with the capacity of option 2;

3100000: 194880 \approx 16 information channels with the ability of option 3.

Thinking similarly, you can calculate the required number of information and news channels targeted at specific target audiences or the number of channels of the required level of popularity and quality of information materials. However, it is clear that the qualitative assessment of information materials, their favorableness, and i.e., the impact on public opinion during the year cannot be equally effective. The success and effectiveness of the information channel depends on staffing, training, acquisition, purchase of technical means for the development of materials and many other factors.

3. Conclusions

The main goal for the system of strategic communications of the Ministry of Defense and the Armed Forces of Ukraine is to achieve a strategic narrative. As noted, the positive statistics of public opinion on support for EU accession is somewhat reduced, so such a narrative for this system should be the formation and strengthening of public opinion on supporting the strategic course of the state.

The application of the proposed mathematical tools to determine the required number of tools (information channels) in the interests of implementing the strategic narrative of the state on the basis of analytical model of information dissemination, will reasonably form the need and scope of information and psychological impact on target audiences, and the quality of news channels. This will provide an opportunity to identify the main tasks for the system of strategic communications and realize the interests of the state in the form of public support for the strategic

course of the state to gain full membership of Ukraine in the EU.

Further development of this study should be carried out on the basis of modern scientific methods of the theory of social research and the theory of information operations in order to identify time indicators that characterize the distribution of materials of information influences to each target audience. It is especially important to receive such information from the temporarily occupied territories of Donetsk and Luhansk regions, as well as the Autonomous Republic of Crimea, which will allow to reasonably identify target audiences, argue the subject of messages and channels of information and psychological influence. To ensure the optimal total information impact, it is advisable to carry out a scientifically sound distribution of the projected total volume of tasks between the various structural units of the system of strategic communications, taking into account the characteristics of different target audiences. This will provide an opportunity not only to specify the goals and objectives for each structural unit of the strategic communications system, but also to develop effective and efficient materials of information and psychological impact to achieve them. This will allow to argue the subject of messages and choose the channels of distribution of materials of information and psychological influence, taking into account the individual characteristics of target audiences.

Reviewer: Doctor of tech. sciences. Professor Evseev S.P., Head of the Department of Cybersecurity and Information Technology, S. Kuznets Kharkiv National University of Economics.

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