Modeling the Dynamics of Information Panic in Society. COVID-19 case

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Abstract

Global processes and their trends that occur in various fields of knowledge with a significant acceleration affect the development of information technology. The modern world is a world in which the media and social networks play a dominant role in the formation of a certain model of the world in the minds of individuals. Naturally, the consciousness of each person has a certain "information filter", the functional ability of which varies greatly depending on the characteristics of the person. The "strength" and capacity of this "filter" are influenced by many factors, which are the subject of a separate study for psychologists. Thus, let us accept the fact that this "filter" exists, and it is he who is responsible for the fact that a person filters all information coming to him in a certain way. And this applies to any information received by a person, including negative information. Most people, having received a portion of negative information - about politics, economics, natural disasters, pandemics, react in a certain way, primarily on an emotional level. For some, the first emotional reaction is gradually extinguished, and the action of the information negatively ends without causing any consequences. For others, a weak information filter allows a reaction in the form of fears, which may exist up to a certain moment, and then either the fear disappears, or, receiving a new informational "feed", that is, a new portion of negativity, increases.

Keywords 1

Information entropy; panicdemic; energy; external environment

1. Introduction

The existing "information filter" for some people may not "survive" with certain portions of negative information and a certain frequency. But with an increase in the intensity of the information negative, even in people "stable" in this aspect, the filter may not cope.

At the same time, it should be noted that for some people, information negative causes a desire to relay it further - to acquaintances, relatives in live communication, and to anyone on social networks. Part of the environment reacts to this information message, which plays the role of a catalyst in the dissemination of negative information. It's no secret that positive information often causes less reaction than negative information. Thus, the process of further movement and strengthening of negative information is launched.

So, for some people, during the spring lockdown of 2020, the information in the news and social networks about the mortality rate from COVID 19 in Italy, videos, and reports about the dire consequences of this virus in the north of this country (where the highest and unexplained mortality rate was observed in that period) caused serious psychological and psychological consequences in the form of panic and a desire to “infect” your environment with it.

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Thus, negative information plays a destructive role in society. Taking into account the current situation, the problem of studying the impact of the growth of negative information in society on its state is urgent.

The issues of the impact of information negativity on society are considered in works [1,2], where this impact was studied in the context of a modern pandemic, generated by COVID 19.

Entropy is a universal category for assessing the state of a system in the process of its life. And for social systems, this category has found wide application. Examples of such studies are [3-14]. In works [15-19], the basic provisions of a new, entropy concept at the organization level are presented and formulas are obtained for assessing entropy and studying its dynamics. These results (in particular, [16,17]) can serve as a basis for further research related to assessing the state of society in conditions of negative information impact and identifying critical conditions.

We will introduce the concept of "information panic" as Panicdemia, by which we mean panic in society generated by information sources (media, social networks, and other types of human communications) and leading to negative consequences for the entire society. The nature of information panic is a fear of prolonged action, generated and amplified by the media and human communications throughout society. Panic is based on fear associated with certain events (for example, a pandemic), but it is the informational impact that turns the fears of individual individuals into information panic at the level of the entire society.

Note that information panic should be distinguished from panic, which, for example, occurs in a certain region during natural disasters or during emergencies in a certain place at a certain time. In this situation, the media and social networks, of course, spread information negatively, but it is "justified", so to speak, a real threat to human lives at a given time in a particular region or place. Thus, in such cases, as a rule, panic occurs only among those who are involved in the specified situation. Note that for individual individuals with a weak information filter, negative information about such an event can also cause fears and lead to panic, but this is the psycho-specificity of these individuals and does not apply to society as a whole.

The emergence of information panic in society is a consequence of a complex information impact on individuals, in the process of which their fears are transformed into social psychosis - information panic. The scheme for increasing the volume of negative information in the process of communication and the impact of the media is shown in Fig. 1. When the total amount of negative information associated with a certain situation (for example, a pandemic) in society exceeds a certain critical value, it can be stated that society is in a state of information panic.

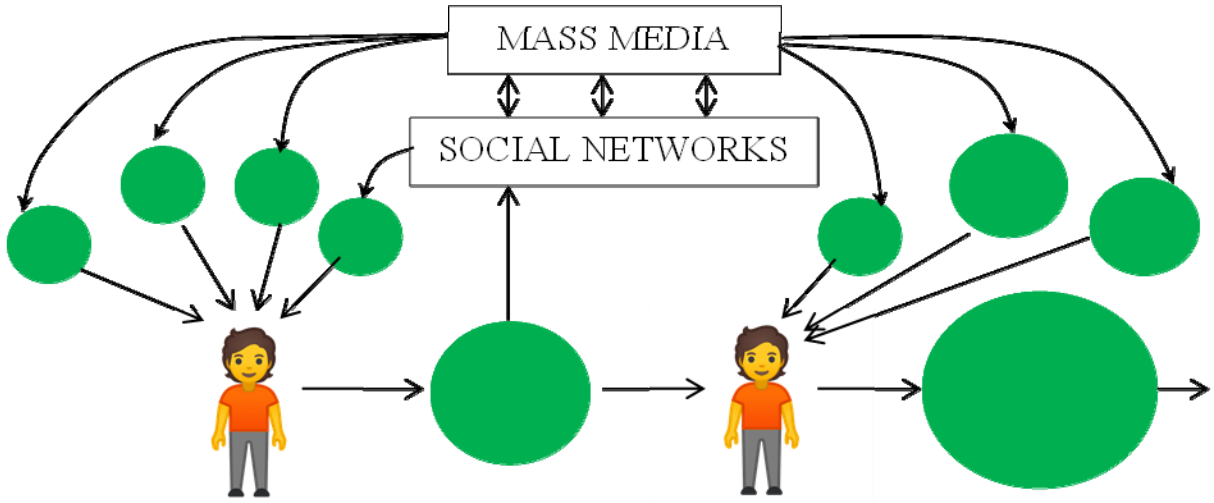

Figure 1: The influence of media and human communications on the formation of information panic

Such an increase in negative information, the formation of general fear, and, as a consequence, information panic can be carried out according to various scenarios (Fig. 2).

In the figure, the critical level is set in a conditional volume. The zero points is the amount of negative information that is observed in the normal state of society.
Scenario 1 - negative information in society gradually increased and at the same rate returned to its original value.
Scenario 2 - there is a slow growth of negative information, which may further go beyond the critical value.
Scenario 3 - the amount of negative information grows rapidly, reaching a critical level, and at this peak point it also rapidly decreases.
Scenario 4 - negative energy grows with acceleration, rapidly passing over the critical level, and information panic has arisen in society.

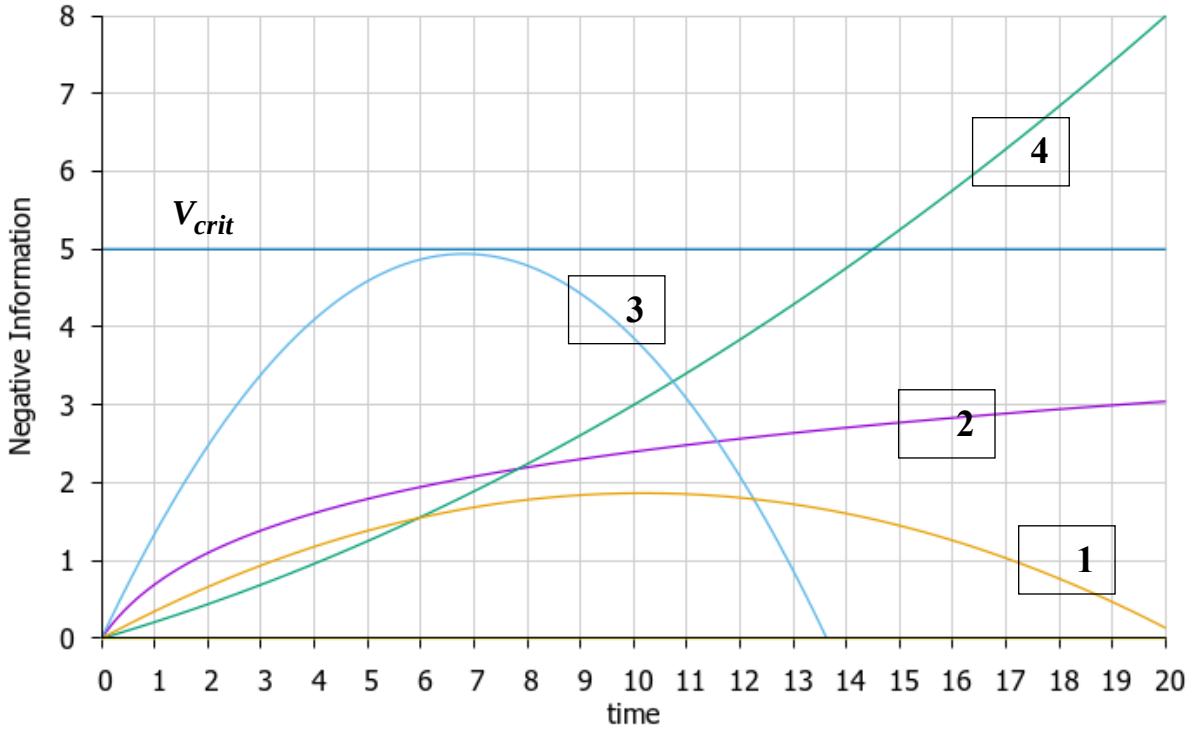

Figure 2: Scenarios for the development of information panic (negative information is presented in a conditional volume)

What are the consequences of information panic?
How do you assess the power of information panic?
Since information panic is the state of society or society as a whole, an indicator is needed that would assess this change in the state of society under the influence of information negativity. At the same time, the essence of information panic should play the role of a black box - this study does not consider the processes of its formation, but examines the result of the impact, which allows us to conclude about its presence and strength.
The most suitable for this purpose is the use of entropy, which, having initially received its place in thermodynamics within the framework of the second principle, gradually began to be used in other aspects and for systems of different nature. Entropy in thermodynamics characterizes the uselessness of energy, and it is the change in entropy that gives an idea of the state of the system under consideration.
In [17, 18], the main provisions of the entropy theory of organization were presented, within the framework of which the connection of entropy as a measure of energy uselessness with Shannon's informational entropy was substantiated. Since the organization is a mini-society, some of the results [17, 18] can be developed and extended to society in a broad sense to solve the problem under consideration.

So, by the entropy of society, we mean the measure of the uselessness of its energy. The entropy concept is based on the universality of the energy balance, which can be represented as:

$$U = A + \Delta U + Q = A + \Delta U + T \cdot S, \quad (1)$$

- where is the total energy of society; - energy gain; A - work; Q - heat, which is formed under the influence of temperature T and S entropy (energy entropy).

From the standpoint of the entropy concept, we define the following categories for society:

• "energy" is the aggregate resources of society (goods, estimated in monetary terms);

• "work" - performance of the main function of society for the reproduction of goods;

• "energy gain" - an increase in benefits as a result of the performance of the main function of society;

• “heat” - energy consumption for maintaining systemic connections in society (according to [20] - payment for the structure);

• “temperature” is a relative indicator of the state of society in comparison with a certain ideal state;

• "entropy" - an indicator of the state of society in the context of its energy losses (dissipation) in the process of energy turnover.

So, the main function of society is to ensure the reproduction and growth of benefits - the energy of society.

The temperature of a society reflects its state in comparison with a certain ideal state, for which we take the following:

• complete certainty (society reliably knows the value of future benefits, which are formed as a result of its main function);

• maximum possible energy efficiency - an increase in benefits as a result of the performance of the main function by society.

Therefore, as the temperature of society, we take the measure of its energy efficiency according to [17]: $\eta=\frac{U+\Delta U}{U}$ concerning information entropy, which characterizes order and certainty:

$$T = \frac{\mu}{H} = \frac{U + \Delta U}{U \cdot \eta^{id} \cdot H}, \quad (2)$$

$$\mu = \frac{\eta}{\eta^{id}}, \quad H = -\sum_{k=1}^{K} p(A_k) \cdot \ln(p(A_k)), \quad (3)$$

where A_k are the options for the state of society from the point of view of obtaining benefits, $p(A_k)$ are the probabilities of these states; μ reflects the relative level of efficiency in comparison with the "ideal" level η^{id} (for example, the level of increase in benefits in economically successful and developed countries). reflect the reproduction and growth of goods, that is, options.

Expression of entropy, taking into account the designations following [18]:

$$S = \frac{(U - E^{in}) \cdot U \cdot \eta^{id} \cdot H}{U + E^{in} - E^{ex}}, \quad (4)$$

where $A+\Delta U=E^{in}-E^{ex}$ is the difference between the expended E^{ex} and received E^{in} benefits.

What happens to the entropy components in the process of increasing information panic? Analyzing the situation in the global society, starting with the spring 2020 lockdown related to COVID-19, the following conclusions can be drawn:

1) information entropy H is growing rapidly since variants A_k with a sufficiently high probability cease to prevail in their structure. In this case, the number of options becomes larger, and their probabilities tend to equalize;

2) E^{ex} begins to decrease: the business has already partially suffered losses during the pandemic, therefore, it is reducing operating costs, also carefully investing in development, many projects are frozen or their scale is being revised. Consumers are also holding on to their savings and spending less on a traditional set of goods, especially when a significant portion of the population works remotely;

3) E^{in} also decreases: business income decreases, therefore, accordingly, incomes of individual individuals associated with this business decrease.

Summing up, we can summarize the following: with the growth of information panic, the uncertainty of the future benefits of society grows, its spending and income decrease, that is, the energy stops circulating, providing a certain level of efficiency, and acquires the property of "uselessness".

So, with a decrease E^{ex}, there is a decrease E^{in}, and, ΔU consequently, the efficiency of the benefits of society decreases μ. Thus, in the expression of the temperature of society (2), the numerator decreases, and the denominator, taking into account the growth of information entropy *H*, increases. This leads to an increase in the temperature of society *T*. In this case, entropy (4) also grows.

Thus, to assess information panic in society, it is proposed to use the change in entropy ΔS, namely, the rate of its growth in comparison with the base level, which is the essence of the information panic indicator:

$$I_{panic}=\frac{\Delta S}{S(t_0)}=\frac{S(t_i)-S(t_0)}{S(t_0)}, i=1,2,3.. \quad (5)$$

where t_i these are the time points for measuring the entropy, t_0 is the initial (base) moment. When $\Delta S>0$ the entropy grows, $I_{panic}>0$. Accordingly, I_{panic} at the entropy decreases, and. The information panic indicator demonstrates how much the entropy of the society has changed under the influence of negative information impact, leading to information panic.

In the normal state of society, the entropy *S* should gradually decrease due to a decrease in the information entropy *H* and an increase in the efficiency of the benefits of this society. In an extreme case, the entropy *S* can remain at the same level, its insignificant fluctuations are permissible. Accordingly, in the normal state of society $I_{panic} \le 0$, and a positive value $I_{panic}>0$ indicates the presence of information panic in society.

The question arises - which level I_{panic} is critical, and what happens when this indicator goes beyond this critical value? As you know, the growth of entropy accompanies the appearance and growth of chaos in the system, therefore, it is obvious that the growth of entropy in society also indicates the approaching chaos (Fig. 3). Therefore I_{panic}, it is a kind and indicator of chaos in society under the influence of information panic. Note that determining the critical level requires separate studies based on the processing of a significant amount of statistical data, which can be done in the future. In any case, if, $I_{panic} \to I_{panic}^{crit}$ then chaos is brewing in society.

The chain of events in Fig. 3 can be interpreted as a Markov chain. Note that the states "Growth of negative information" and "Reduction of negative information" can be represented in more detail in the form of several events with different levels of negative information and I_{panic}. This chain can serve as the basis for the Markov decision process, based on which modeling decision making in situations where outcomes are partly random and partly under the control of a decision-maker is carried out. The role of the latter, in this case, is played by the media, social networks, and those who can influence them. Having probabilistic assessments of transitions from state to state and their changes as a result of the influence of a decision-maker, one can assess the state of society after a certain period.

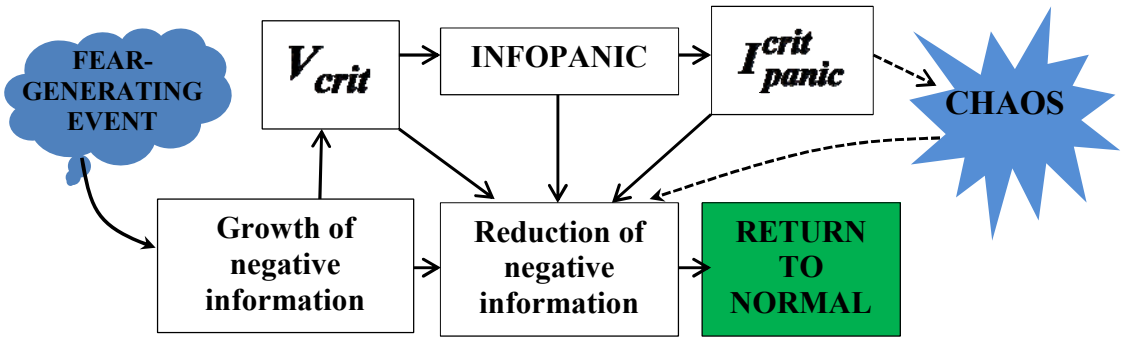

Figure 3: The logical relationship of various states of society from the position of information panic

Let us consider, using a design example, how an increase in informational entropy H and a decrease E^{ex}, E^{in} affect the level I_{panic}.

An increase in information entropy H under the influence of information panic can occur both linearly and according to a polynomial pattern or even exponential, therefore, consider the following options for the growth of H:

$$H=a+b\cdot t, \tag{6}$$

$$H=a\cdot t^2+b\cdot t+c, \tag{7}$$

$$H=d\cdot e^{f\cdot t} \tag{8}$$

where a,b,c,d,f are numerical coefficients, $0<d,f<1$. A decrease E^{ex}, E^{in} can also occur at different rates with similar H dependences, only in this case $d>0,f<0$. Figure 4 shows the variants of the dynamics of the entropy of society for different dynamics of the information entropy H with other fixed conditions. Figure 5 shows the dynamics of the entropy S with a simultaneous change in the information entropy H and energy flows, E^{ex}, E^{in}.

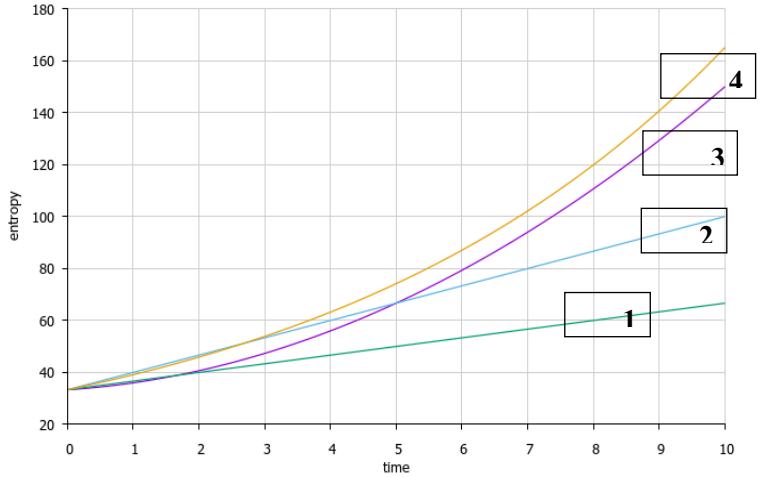

Figure 4: Dynamics of entropy S for different dynamics of information entropy H: 1 option; $H=1+0,1\cdot t$ Option 2 $H=1+0,2\cdot t$; Option 3 $H=1+0,05\cdot t+0,03\cdot t^2$; Option 4 $H=e^{0,16t}$.

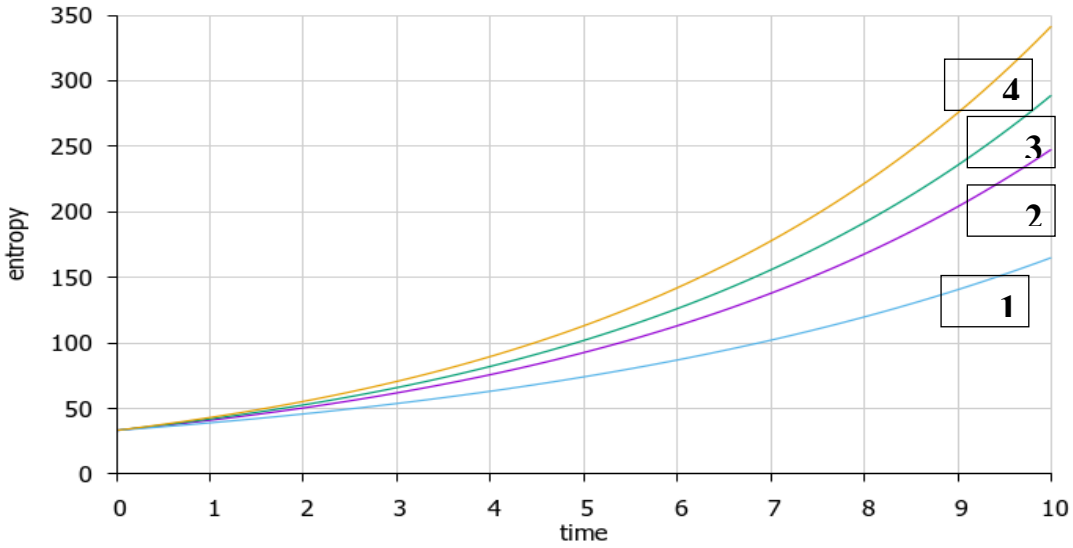

Figure 5: Dynamics of entropy S for different dynamics E^{ex}, E^{in}, and information entropy $H=e^{0,16t}$: 1 option, $E^{ex} = const; E^{in} = const$, Option $E^{ex} = 20\text{-}t; E^{in} = 30\text{-}t$; Option 3 $E^{ex} = 20\text{-}1,5t; E^{in} = 30\text{-}1,5t$; Option 4 $E^{ex} = 20\text{-}1,8t; E^{in} = 30\text{-}2t$

As you can see, only under the influence of the growth of information entropy there is a significant increase in the entropy of society (Fig. 4), but several times its growth becomes faster and more significant with a decrease in the incoming and outgoing energy of the society (Fig. 5).

The calculation of the information panic index I_{panic} was carried out for the 1st and 4th scenarios of the entropy dynamics shown in Fig. 5. The calculation results are shown in Fig. 6.

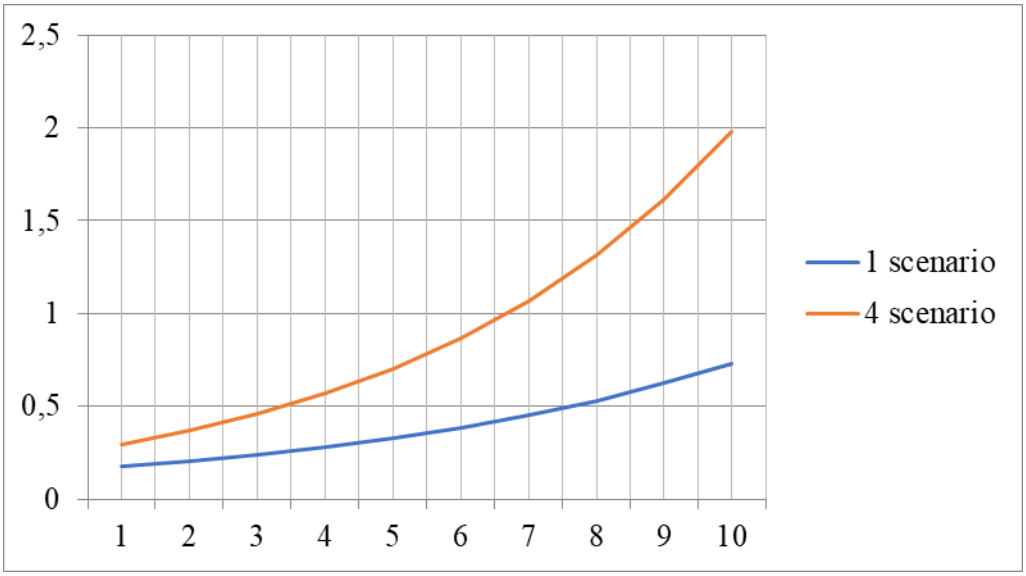

Figure 6: Dynamics I_{panic} for different dynamics of entropy.

As you can see, the information panic index for the 4th scenario increases significantly. Even if we assume that the critical value $I_{panic}^{crit} = 1,5$ (that is, a little more than a three-fold increase compared to the initial level), then in the fourth scenario, Panicdemia definitely sets in.

2. Acknowledgments

In this paper, it is proposed to use the entropy concept to identify and analyze information panics in society. Under information panic, it is proposed to understand panic in society generated by information sources (media, social networks, and other types of human communications) and leading to negative consequences for the entire society.

Entropy as a measure of the uselessness of energy is adapted to assess the state of society in the process of increasing negative information impact. Introduced into consideration an indicator - an indicator of information panic, based on the change in entropy.

The influence of various dynamics of information entropy and energy flows of society (movement and growth of goods) on entropy and the indicator of information panic is analyzed using a calculated example in conventional figures.

The main states of society in the process of entropy growth are identified, their relationship is presented in the form of a Markov chain, the initial event of which is an event that generates fear in society; the final event with the endless growth of information panic is chaos.

The results obtained are the basis for further research on the impact of negative information on society and identifying ways to return to its normal state.

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