

# Study on Public Opinion Based on Social Physics

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**Abstract.** Social combustion theory, social shock wave theory and social behavior entropy theory are the three basic theories of social physics. This paper studies on public opinion formation based on social combustion theory, and explores public opinion evolution process based on social shock wave theory, and grasps the individual's whose specifically refers the public opinion leader's behavior based on social behavior entropy theory.

**Keywords:** Public opinion Formation; Public opinion Evolution; Social Combustion Theory; Social Shock Wave Theory; Social Behavior Entropy Theory.

## 1 Introduction

After Conde put forward the idea of social physics nearly 200 years ago, the social physics has experienced such three development phases as the classical social physics, the modern social physics and the contemporary social physics. As an interdisciplinary field, contemporary social physics uses the concepts, principles and methods of natural science to explore, simulate, explants, explain and find out the social behavior rules and the economic operation orders with efficiently extending, properly integrating and rationally modifying[1]. During the last 50 years, great progress has been achieved in this field.

Public opinion reflects the public on certain social reality and phenomenon in a different historical stages, the integration of mass consciousness, ideas and emotion. The subject of opinion is the general public, the object is a particular focus of the community, and the ontology is the tendentious comments or remarks of this focus. "Public opinion comes before the unrest" has become a consensus. Before any major social changes happen, there is always an aura from public opinion. During the changes, some oscillations will be caused on public opinion. After the changes, some public opinions will be persisted to guide new social changes as experience, preparation and reference. Public opinion can be viewed as a social behavior of the public and presentation of forming legal or moral restriction. It's helpful to build harmonious society. In contrast, it can also induce social trouble. Therefore, it's very significant to find out rule of opinion formation and evolvement and then guide opinion infection.

Social physics presents three main theory[2], social combustion theory, social shock wave theory and social behavior entropy theory. Social combustion theory focuses on mechanism of society stability. Social shock wave theory explores spatio-temporal distribution of society stability. Social behavior entropy theory is for essential research on society stability. Social physics insisted that mechanism of opinion formation and evolution, same as process of common incident, involves latent period, active period and close period. When large-scale individuals or group discuss some incident together, it enters active period from latent period of opinion. That indicates that opinion is built step by step and formed at last by integration of local viewpoints with key points from opinion leader. The level of opinion formation during different stages can be quantitatively decided by number, scale and intensity. In the following parts, social physics will be applied to study opinion formation and evolution. In detail, social combustion theory will be used to study mechanism of opinion formation, social shock wave theory is used for exploring process of opinion evolution, and social behavior entropy theory is used to analyze behavior of participants, mainly opinion leader, in opinion 'Ba'.

## **2 Studying on the Mechanism of Opinion Formation Based on Social Combustion Theory**

### **2.1 Social Combustion Theory**

Social combustion theory, which carries a reasonable analogy between the natural burning phenomenon and social disorder, instability and turmoil, was proposed in 2001. In nature, burning involves not only physics process but also chemistry process. Physics process indicates physical balance conversation of energy, and chemistry process mainly indicates physical change and the related conditions. Burning occurred only if all three basic conditions, namely burning material, catalysis and the ignition temperature or the last straw, exist. That is, any of the three ones is indispensable. The mechanisms of combustion process in nature can also be used for reference during studying on social stability. In detail, the basic cause of social disorder, such as conflict between people and nature and the disharmony between persons, can be viewed as the burning material. The non-rational judgments, malicious attacks by hostile forces and deliberately one-sided interests of the chase will work as catalysis. When both of the above exist, even a small emergency become the ignition temperature or the last straw, thus result in mass incidents with a certain scale and some impact and then cause social instability and discord at last[3].

This research studies on the mechanism of opinion formation based on social combustion theory. There are wide ranges of attitudes, discussions and demands as a collection of burning material. The hierarchical structure in ba of the public opinion will create more opportunities to move closer to consensus, which can be viewed as social "catalysis". What ultimately triggers the formation of public opinion is usually an unexpected incident or an authoritative source of speech. That is "the last straw".

### **2.2 To Determine Formation of Opinion**

Public opinion during the process of collection and formation is presented with two forms[4], view flow and action flow. With view flow, the public continually express

their opinions on some of the social reality and problems to vent their unhappiness. If a high degree of consensus is achieved among the view flows and the demands of the people can not be met, view flow will upgrade to action flow. That is, the individual and unprompted actions become organized and purposeful campaign, to promote the mass outbreak of emergencies. The critical point of opinion formation is the moment when view flow upgrades to action flow[5].

Some of the social injustice invoked a psychological dissatisfaction of people, which plays an important role in preparation for the opinion formation. Those voices of appeal and cumulative negative effects, and so on, can be viewed as burn the material from the people's suffering. Besides, some sensitive words, such as "the rich", "money", "official" and "corruption" etc. will work as catalysis of pricking up public discontent. With the above to preconditions, even a small event can play a role of the last straw. At this moment, the three conditions of opinion formation are in place and a consensus of opinion has been reached. Without active response, the mass incidents leading to crimes against property and social stability will eventually happen.

As a result, research on opinion formation should focus more on the mass incidents caused by the day-to-day events, analyze the opinions against social order and stability derived from public debate or views through continual friction and integration, and then give a correct guidance or even destroy this destructive force in a timely manner to avoid unexpected incidents and protect the security of the people and society property. As an important part of early warning system, Public opinion research will take a prediction role through the grasp of opinion formation mechanism.

### 3 Exploring Opinion Evolution Process Based on Social Shock Wave Theory

#### 3.1 Social Shock Wave Theory

The shock wave is one of the most important phenomena in the high speed of gas movement process. It is the strong compression wave produced by strongly compressed gas, also known as strong inter-section. The thin interruption is called as shock wave[6]. In this thin layer, speed, temperature, pressure, and other physical quantities changes quickly from the wave front value to wave behind value. Also, the gradient of speed, pressure and temperature are great. Therefore, the shock wave theory is not very concerned about the flow in wave, but just explores changes of physical quantities after going through the shock wave.

At present, some ideas are absorbed from the shock wave theory to solve complex social problems, especially for those problems with wave phenomena, such as traffic[7], the flow of people[8], etc. The crowded can be viewed as a continual medium because any crowd disturbance is spread in the crowd with the form of waves. Besides, due to individual differences, non-linear distortion occurs on waves, which may result in the shock wave, crowded accident.

Some methods, such as Ising model[9-12], Sznajd model, Deffuant model, Krause-Hegselmann model[12-14], Rumor Spread model, Bankruptcy model, and Monte Carlo model have been proposed to study the process of opinion formation based on the social shock wave theory.

### 3.2 Modeling for Opinion Evolution

Public opinion is a spread of the surface sense, exhibited up and down. Because people accept the views with different speed ability, there is different intensity of reaction. As a result, a wave of ups and downs can be felt due to such a gap caused different intension of spread. This status has been called the "wave of public opinion"[15].

Wave of public opinion is spread with non-linear form and involves some people as participants. During opinion infection, the behaviors of the participants can be classified [16]. This paper summarized them as "conformity", "power" and "egoism". In detail, "conformity" involves more psychological factors. Participants are fear of loneliness and obey to majority. "Power" mainly involves the moral values. Whether power or prestige is decisive factor, which is especially important in China. "Egoism" is driven by people's values. For some benefit, people may even change their words and deeds. Therefore, the "conformity", "power" and "egoism" are fundamental for the establishment of opinion infection simulation rules.

Hypothesis: there are  $N$  opinion subjects, each of them owns viewpoint  $o_i$ , where  $i = 1, 2, \dots, N$ .

**Definition 1:** The three basic elements of opinion infection involves {  $\sigma$  : change of public behavior ;  $E$  : environment of opinion infection ;  $t$  : time of opinion infection }, as following,

$$Y = F(\sigma, E; t) \tag{1}$$

where,  $Y$  is speed of opinion infection on some social phenomenon or incident.

**Definition 2:** The choices of actions of the public include {  $S$  : choice of individual preference ;  $S'$  : the interaction between individuals }, it can be expressed as,

$$\sigma = f(S, S') \tag{2}$$

**Definition 3:** Choice of individual preference is based on {  $c$  : "conformity",  $p$  : "power",  $l$  : "egoism" }, it can be expressed as,

$$S = \psi(c, p, r, l) \tag{3}$$

Among them, individuals  $i$ , with influence from the above-mentioned action models, will build their abilities in adhering to their originally owned viewpoints between time  $t$  and  $t + 1$ .

Opinion diffusion is the process of choosing or being persuaded of each individual. Participants (or part of them) get agree on behavior finally. Therefore, the law of gravity can be referred to reflect change of individual behavior between moment  $t$  and  $t + 1$  due to interaction. That can be expressed as,

$$\sigma_i = \sum_{j=1}^N k \frac{o_i \bullet o_j}{d_{ij}^\alpha} \quad (4)$$

where,  $k$  is the constant coefficient,  $d_{ij}^\alpha$  represents the distance between the individual  $i$  and individual  $j$ ,  $\alpha$  is the parameter of power,  $o_i \bullet o_j$  describes the consistency between the individual  $i$  and individual  $j$ .

If  $o_i \bullet o_j > 0$ , individual  $i$  has the same viewpoint as individual  $j$ , then individual  $i$  will hold the original viewpoint.

If  $o_i \bullet o_j < 0$ , individual  $i$  has the opposite viewpoint to individual  $j$ , then, we can take following two conditions:

when  $\sigma > 0$ , individual  $i$  will hold the original viewpoint.

when  $\sigma < 0$ , individual  $i$  will change its proposition.

## 4 Recognizing the Individuals Who Specifically Refers the Opinion Leader's Behavior Based on Social Behavior Entropy Theory

### 4.1 Social Behavior Entropy Theory

Social behavior entropy is the essence of social unrest. The entropy theory in physics field is used for preference to explain the composing of group from individuals. There are six principles of social behavior entropy theory[1], namely 1) Universal "minimal effort" principle, 2) Pursue "Minimum entropy" principle, 3) Keep "psychological balance" principle, 4) Sustain "EQ resonance" principle, 5) social orientation "was the trend-U" Principle, and 6) Long for social convention that limits any other people except himself.

During the process of public opinion formation and evolution, we may mainly concern with "psychological balance" principle and sustain "EQ resonance" principle.

"Psychological balance" principle. If the individual could calm down through persuasion and self-reflection after suffering some unfairness, great help can be provided for the building of a harmonious society. In other words, by persuading the participants can achieve self-acceptance, self-awareness, self-experience and self-control.

Sustain "EQ resonance" principle. "EQ resonance" means that only the people who owns most respect, reputation or approbate is allowed to play a role for persuading. Whether to the public or to government leaders, an example is very significant.

The individuals always unconsciously follow some of the rules from social behavior entropy theory. Moreover, the above two principles indicate that the individuals prefer to seek the emotional support and the dependence on attitude from opinion leaders. This explained the indispensability of opinion leaders.

## 4.2 Recognizing Opinion Leaders

Public opinion is often spread through interaction between persons and realized the effect on changing attitudes and behavior of audience. Generally, opinion is transmitted from popular media to opinion leaders and in turn transmitted to people who the leaders want to influence, which is called secondary communication. Opinion leaders can be treated as audience and also leaders to influence audience. They play a very important role during opinion infection.

Recognizing opinion leaders during opinion formation and evolution and then finding out their behavior mode and path is an important method to guide opinion infection. This article adopted social network analysis (SNA) method to identify opinion leaders. SNA is proposed in 1930s and enhanced in 1970s. It's a new paradigm of sociological research. SNA is used to recognize quantitatively "opinion leaders" because this approach exactly described the relationship between the subjects of opinion. Each point in social network represents a participant. The connected points further represent a group of individuals with similar viewpoints. The role in network means the combination among points.

Some other concepts such as point, edge, degree, betweenness, cutpoint, component, subgroup and centralization and so on are involved in SNA. The cutpoint is the point whose absence will divide network into segments. Such a point in is important to not only network but also the other point, also of important significance. As a result, cutpoint plays the "opinion leaders" role among the subjects of opinion. Algorithm for computing and finding out cutpoint will not be studied in detail here.

## 5 Conclusions

With perspective of social physics, this paper tries to explore the mechanism of opinion formation and evolution based on social combustion theory, social shock wave theory and social behavior entropy theory. This research is significant to recognize essence of opinion and then guide opinion infection efficiently.

According to result presented in this paper and previous research, it can be summarized that the key value of opinion is from its prediction and alert function, and proper propagandize from media is taken, as a way to guide opinion infection, to get full, harmony and sustainable development of society.

Opinion keeps watch on stability of society. It can be used as the benchmark or wind vane to judge social stability and harmony. By having an alert for the potential mass incidents based on analysis and forecasting of opinion formation and evolution, the prediction and alert function of opinion is fully presented. Building a fair and harmonious social environment can not only inhibit the breeding ground for rumors also enhance the prestige and credibility of the government.

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