

# On Vulnerability of Corporate Value Net Based on Self Adaptation Complexity System

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## Abstract

Corporate value net is the business carrier for social economy to run effectively. However, “sudden adversity” or “disaster” often happens in corporate interior and exterior, which results in crisis finally to vulnerable corporations, such as American Lehman Brothers and Chinese Sanlu. Our hearts still flutter with fear till now when thinking of them. This paper is to study the emergence, inspiration, diffusion and obstruction of vulnerability of self adaptation system complexity of corporate value net. And then we shall propose theoretical basis and methodology instruction for corporate decision making to confront vulnerability.

**Keywords:** Vulnerability, Self Adaptation Complexity System, Corporate Value Net

## 1. Preface

Since G. F. White, an American scholar, brought forward the concept of “vulnerability” in his book “Natural Hazards” in 1974 for the first time, it is widely applied in natural science field, such as ecology and catastrophology, and social science field, such as sociology and economics. For instance, some famous conceptual models studied vulnerability based on ecology and catastrophology, such as RH (Risk-Hazard), PAR (Pressure-and-Release) and HOP (Hazards of Place). All these models studied the basic reason of ecological vulnerability from different perspectives. The scholars who studied vulnerability based on economics are Zeng Shihong, Zhang Wugang, Wu Manman and so on. They studied the emergence cause, evolvement and target system making of financial vulnerability respectively. Besides, others studied vulnerability of system complexity on the basis of system complexity theory, such as Rong Panxiang, Li Qi and Jin Hongzhang. They studied the emergence cause and evaluation of vulnerability of system complexity, and provided vulnerability research with some fundamental theoretical analysis methods.

However, through relevant literature review we find out at present the researches on “corporate vulnerability” from management perspective are relatively few in China and even internationally. The concept of “vulnerability” is seldom introduced to corporate management. A few relevant literatures mostly involve vulnerability research of individual parts or aspects on corporate management. For example, Wen Hua studied the evaluation system of corporate vulnerability. Pidgeon, Rudolph, Repenning, Zhang Liangsen and other scholars researched on correlation of corporate culture, interference convergency scale, and business growing speed and other factors, and organizational vulnerability. On analysis and evaluation of corporate vulnerability, Ning Zhong, Chi Xinyun, Zhang Hongliang and so on respectively studied relevant questions of vulnerability from different perspectives, such as supply chain management, corporate governance structure, and specific project investment. Meanwhile, Yang Libing and Cheng Yuncai studied corporate vulnerability from security perspective.

From the above stated, we see scholars have obtained some achievements on research of corporate vulnerability, furthermore, the research tendency is getting hotter and hotter. But there is still no literature on vulnerability of corporate value net based on systematic theories, which is very significant. Therefore, this paper will further the research on internal system of emergence, inspiration and diffusion of vulnerability of corporate value net on the basis of existing theories in order to provide corporations inside corporate value net with theoretical base to confront diffusion of vulnerability.

## 2. Emergence and Inspiration of Vulnerability of Corporate Value Net

Relevant literature review shows the concept of value net was firstly raised by American David Bovet in 2001. In his research he points out corporations should change business design and transform traditional value chain into value net due to increasing customer individual demand, internet impact and keen market competition, so as to adapt random and multi demand business society along with globalization, digitization and speediness of market response. Value net theory claims that mutual effect among participators in value net represents in two aspects. One is the vertical relation between customer and supplier who both do business with the corporation, and the other is the horizontal relation among the corporations, who are substitutes and complementarities, with mutual effects but without business transaction with the corporation. Thus, corporate value net, the system complexity, can be divided into five subsystems, i.e. “supplier”, “corporation”, “customer”, “substitute” and “complementarity”, which are respectively influenced by different vulnerability factors and have their own inherent vulnerabilities.

The vulnerability of corporate value net consists of accumulation vulnerability and impact one. Accumulation vulnerability of system complexity in corporate value net means during the development process of value net system, some vulnerable factors harmful to corporate development inside or outside corporation gradually and negatively accumulate in small quantity, so systematic vulnerability will emerge and accumulate continuously. When it reaches to certain extent, value net system will collapse and can't recover to normal running any more. Impact vulnerability of system complexity in corporate value net means value net system is extremely sensitive to the interference of environment or one or more internal vulnerability factors. When it changes, the system will make qualitative change in rather short time and can't recover, even collapse. The most prominent external characteristic of this vulnerability is that the system will collapse immediately when its sensitive factors change. It is hard to recover, even for a long time. The inspiration process of vulnerability is as following, both for accumulation vulnerability and impact one.

Figure 1 indicates the most basic reason of inspiration of vulnerability in corporate value net comes from plenty of factors in environment or value net which cause “incidents”. Under the impact of all these “incidents”, the sequence of subsystem is likely to be broken and consequently vulnerability may be inspired. For instance, in supplier system, the supply chain breaks up when encountering irresistible incidents, suppliers act illegally or bidding cheat, and suppliers provide with inferior products. In customer system, purchase mode changes, customer loyalty declines and consumer preference changes. All these above are likely to arouse incidents and finally inspire vulnerability of whole corporate value net.

## 3. Diffusion and Obstruction of Vulnerability of Corporate Value Net

The above inspiration model of vulnerability of system complexity in corporate value net illustrates factors arouse impactive incidents, subsequently impactive incidents inspire vulnerability of subsystem, and finally vulnerability of subsystem inspires vulnerability of corporate value net. Obviously, this just illustrates the inspiration process of different levels, but there is another level. That is to say, vulnerability is not inspired in all subsystem simultaneously, but firstly in partial subsystem, and then this partial inspiration will arouse the inspiration of vulnerability of the other surrounding subsystems at same level. Partial inspiration of vulnerability will be diffused and represents to be overall one. The diffusion mechanism is as follows:

We assume that one subsystem in corporate value net, X, collapses impacted by one strong interference factor. Due to the coupling effect among subsystem, this must cause at least one  $y_i$  among other status vectors  $Y_i$  ( $i=1, 2, 3, \dots, m$ ) correlated with its vulnerability, generates vulnerability change influenced by vulnerability correlation. If this change reaches the scope within which functions of status variables corresponding to subsystem don't work normally, vulnerability of this subsystem will be inspired. Vulnerability inspired by subsystem Y will arouse inspiration of vulnerability of correlated subsystem as well, so vulnerability is diffusing. The diffusion process includes the following three modes.

### 3.1 Diffusion of Vulnerability inside Corporate Value Net Based on Domino Linear Model

The domino effect is a chain reaction that occurs when a small initial energy (small change) causes a similar change nearby. The domino model is established based on this phenomenon. In this model, each domino represents a subsystem (as stated above, according to present value net theory, system complexity of corporate value net can be divided into multi- and random five subsystems, i.e. customer, supplier, substitute, complementarity and corporation, so there are only five dominoes in the model) among system complexity. And the distance between any two dominoes represents the intensity of vulnerability correlations between the corresponding subsystems, see Figure 2. When one domino X (subsystem X) collapses, it will influence domino Y (subsystem Y) directly correlated to it first. But whether domino Y will collapse depends on its intensity of

vulnerability correlations with surrounding falling dominoes and the resilience of itself.

As for the diffusion process of vulnerability inside corporate value net in domino linear model, we can take the collapse of Sanlu Milk Powder Group as an example. There is melamine in original milk, which is a primary incident factor arousing vulnerability. This incident factor caused “sudden adversity” or “disaster” in purchase subsystem of the Group. Then the inspiration status of elementary vulnerability in purchase subsystem diffused to other correlated subsystems, such as production system, customer system, finally resulting in the collapse of Sanlu Group.

### *3.2 Diffusion of Vulnerability inside Corporate Value Net Based on Pyramid Structure Model*

According to system complexity theory, system complexity has a very common character—level, besides openness, complexity, bulk, vulnerability, evolution and emergence. Thus, a pyramid structure model can be established as Figure 3.

The corresponding organizational mode of this model is the most common pyramid organization, whose diffusion mode can be divided into up-to-down model and down-to-up model. For easy analysis, we assume the collapsing subsystem intensively interfered is the top or bottom. Up-to-down model means when the subsystem on the top collapses by interference, subsequently the vulnerability of those correlated subsystems with coupling effects will be inspired continuously, which shows the diffusion of vulnerability from up to down. And collapsing subsystems are more and more, moreover, the transfer direction is from up to down.

The down-to-up model means after a comparatively small subsystem at the bottom collapses due to intensive interference, consequent vulnerability of system complexity will diffuse from down to up. And collapsing subsystems are more and more, and at last the whole system complexity breaks down. This phenomenon usually occurs when sudden crisis incidents happen in some important departments of a core supplier in the value net. For instance, the 22<sup>nd</sup> wafer factory of Philips got lightning strike on Mar. 17<sup>th</sup>, 2000. At beginning, Philips' self-vulnerability was inspired from point to plane, with 40% declining of orders compared to corresponding period. Subsequently, the vulnerability of Ericsson was inspired because of products' correlations (the lack of necessary parts caused supply gap of millions of chips). Consequently, top mobile phone market share shrank from 12 to 9%. Thus, the systematic vulnerability diffused from a fundamental “rather small wafer factory”, from interior to exterior, from point to plane, and finally to the top core corporation, Ericsson.

### *3.3 Diffusion of Vulnerability inside Corporate Value Net Based on Cellular Automaton Model*

The above described domino model and pyramid model are some special models which represent the vulnerability correlations between subsystems at same and different levels in system complexity. However, there is a more common situation. A subsystem, neither on top nor at bottom, collapses by interference. Cellular automaton can be used to describe its diffusion process. Cellular automaton is a grid dynamics model with discrete time, space, states and locality of spacial interaction and temporal causality. The model consists of five factors, i.e. cellular, cellular space, neighbor, cellular states and evolution rules. The famous two-dimensional cellular automaton includes extensive Moore model, Von. Neumann model and Moore model, which are shown respectively as Figure 4 (a), (b) and (c).

The diffusion process of vulnerability in corporate value net based on cellular automaton model regards different subsystems as different cellars. When one cellular collapses interfered or impacted internally and externally, it will arouse vulnerability of other surrounding correlated subsystems. So the inspiration states of vulnerability will diffuse around in many directions. The degree and scope of diffusion depend on vulnerability correlations among different subsystems and vulnerability resilience of subsystem per se.

The diffusion system based on vulnerability of corporate value net can well analyze the reason that the bankruptcy of Lehman Brothers Holdings aroused worldwide economic crisis. The bankruptcy of Lehman Brothers Holdings affected its investors (customers) first, American finance industry (substitute) next, American industrial economy (complementarity) furthermore, and global economic crisis finally.

From the above described we can see, when a subsystem of system complexity in corporate value net is heavily impacted, the vulnerability of the other subsystems will also be inspired owing to their vulnerability correlations. Therefore, corporations have to take some countermeasures to obstruct the diffusion of vulnerability in order to avoid the collapse of the other subsystems of system complexity in whole value net as for the correlations. These countermeasures could be implemented from the following aspects.

3.3.1 Ideologically, top managers in corporate value net should strategically emphasize systematic vulnerability so as to obstruct internal diffusion of the vulnerability

The vulnerability of corporate value net doesn't show often, so it conceals usually. It takes on only when suffering strong enough external or internal intensive interference. This character often results in neglecting systematic vulnerability, especially in some small and medium sized enterprises. However, once part (or whole system) of value net collapses under strong impact, other vulnerability correlated systems will collapse subsequently because of concomitant vulnerability correlations. This brings lethal beat to participators of the value net. Therefore, top managers have to note that the vulnerability of system complexity has great harmfulness and destructiveness, which requires top managers to strategically emphasize systematic vulnerability so as to obstruct internal diffusion of the vulnerability

3.3.2 On prevention of diffusion of vulnerability, prevention system of counter diffusion should be established to obstruct internal diffusion of the vulnerability

Vulnerability is a character of system per se and can't be eliminated. But if corporations want to ensure sustainable growth, they have to pay much attention to "sudden adversity" or "disaster" caused by the incidents of "small probability and strong destructiveness" of other corporations, and establish prevention system of counter diffusion to obstruct internal diffusion of the vulnerability. There are three countermeasures: (1) Establish corporate culture with security consciousness and security sensitiveness. They need to establish and cultivate a kind of corporate security culture which could be involved into staff behaviors. It is very significant to restrain the emergence of vulnerability of corporation or value net and to strengthen its resistance; (2) Delaminating equilibrium resistance. Delaminating resistance refers to multileveled obstruction resistance to inspiration of vulnerability in the value net. It will reduce the possibility of inspiration of vulnerability greatly. Equilibrium resistance means prevention project should be useful to any possible threat, and protect corporations against all potential, random, accidental or deliberate destruction by means of cooperation and equilibration. For example, one invests a lot at front door, but it is very easy to get in at back door. This kind of resistance is not an equilibrium, so it is ineffective; (3) Separate threats from baseline. Corporations need to focus on skeleton basic activities ("baseline"), and identify those abnormality (abnormal matters, vulnerability factors inspiring incidents) in daily routine and sequential modes, and then identify whether these abnormalities belong to normal matters or dangerous ones, so that separate threats from baseline.

3.3.3 On controlling diffusion of vulnerability, corporate relations in value net should transform into cooperation game from noncooperation game to obstruct internal diffusion of the vulnerability

Organizational relationship theory claims that any organizational business can't be separated from surrounding relationships. Its existence and achievements usually depend on relationship with other organizations. Therefore, when one corporation in value net gradually collapses due to vulnerability caused by "sudden adversity" or "disaster", one hand, this corporation itself can reduce the scope of correlated subsystems. For instance, after Sanlu Group found out problematic milk source, they can contract production system correspondingly. One the other hand, other corporations in the net, on behavior mode, has to transform into cooperation game from noncooperation game to be consistent and control the diffusion of vulnerability together.

#### 4. Conclusion

In short, along with increasingly deepened integration of international politics and economy, in the keen market competition, once corporations encounter "sudden adversity" or "disaster" (no matter they are political, economic, natural or other dangerous matters of small probability), the inherent vulnerability in value net is likely to be inspired. Moreover, this "inspiration states of vulnerability" will diffuse to other correlated subsystem; furthermore, other subsystems of the system complexity in the whole value net may collapse due to the correlations. Top managers should pay high attention to corporate vulnerability and take corresponding countermeasures to eliminate or weaken corporate vulnerability in order to ensure corporate healthy and sustainable development. Although we make some primary discussion on vulnerability of corporate value net, there are still spaces on how to implement counter diffusion measures to obstruct diffusion of vulnerability for further research.

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#### References

Chi, Xinyun. (2006). Exploration and Countermeasures on vulnerability of the state-owned enterprise employee congress system. *Chinese staff education*. 2006 (12):48-49.

- Cutter, S. L. (1996). Vulnerability to environmental hazards. *Progress in Human Geography*. 1996. 244: 529 – 539.
- David • Bovet. (2001). *Value net*. Beijing: Posts & Telecom Press. 2001.
- Kates, R. W. (1985). *Climate Impact Assessment*. New York: Wiley. 1985.
- Li Qi, Jin, Hongzhang and Lin, Deming. (2005). Vulnerability of system complexity modeling and analysis method. *Systems Engineering*. 2005 (1):9-12.
- Ning Zhong. (2004). The influential factors of supply chain vulnerability and management principles. *MARKET*. 2004 (4):13-16.
- Pidgeon, N. (1997). The Limits to Safety? Culture Politics Learning and Man-made Disasters. *Journal Contingencies and Crisis Management*. 1997:1-14.
- Rong Panxiang. (2006). On vulnerability of system complexity and its theoretical framework. Harbin Engineering University. PhD thesis. Jun. 2006.
- Rudolph, Jenny W., and Repining, Nelson P. (2002). Disaster Dynamics: Understanding the Role of Quantity in Organizational Collapse. *Administrative Science Quarterly*. 2002:1-30.
- Turner, B. L., R. E. Kasperson & R. A. Matson, et al. (2003). A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences*. 2003.100 14: 8 074 - 8 079
- Wen Hua, Wang Zhan and Yang Qing. (2008). On Enterprise vulnerability assessment index system. *Wuhan University of Technology Transaction (Social Science)*. 2008.21 (3):35-38.
- Wu Manman. (2006). Establishment of China's financial vulnerability index system. Foreign Economic and Trade University. A master's degree thesis. Nov. 2006.
- Yang, Libing & Cheng, Yuncai. (2008). Analysis on corporate emergency management vulnerability. *China Safety Science Journal*. 2008 (4):77-81
- Yossi • Jaffe & Yang, Xiaowen (translator). (2009). *Flexibility ---- essence of supply chain management, Massachusetts Institute of Technology (new management issues ---- disaster management)*. Shanghai: Shanghai Joint Publishing. Nov. 2009.
- Zeng, Shihong. (2003). Financial vulnerability theory—on the regulatory mechanism inspired by banking non-performing loans and the optimal dynamic path. *Chinese Academy of Social Sciences*. Doctoral research papers. Jun. 2003.
- Zhang, Hongliang & Li Peng. (2007). PFI project characteristics on project risky events and vulnerabilities. *Management Engineering*. 2007 (1):102-109.
- Zhang, Wugang. (2007). Vulnerability of the state-owned commercial banks and its trend. *Financial Theory and Practice*. 2007 (2):39-41.



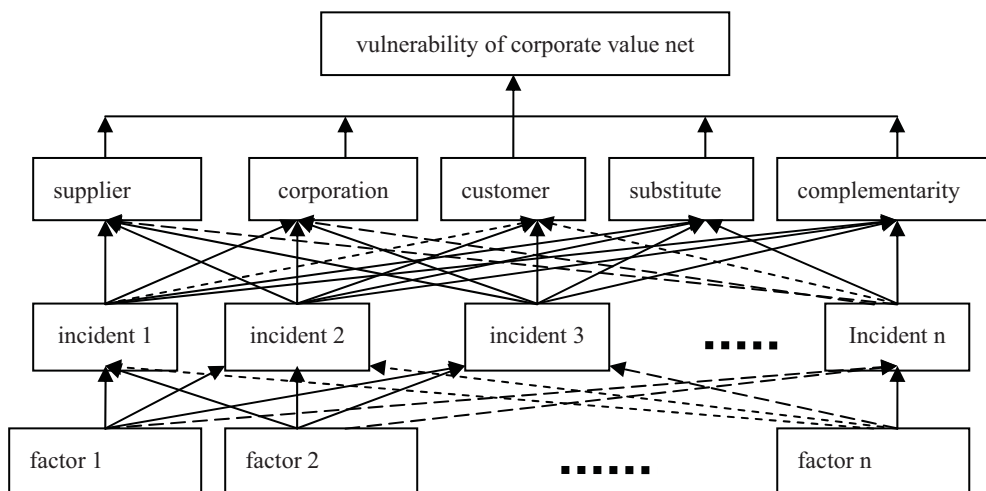


Figure 1. Inspiration Model of Vulnerability of Corporate Value Net

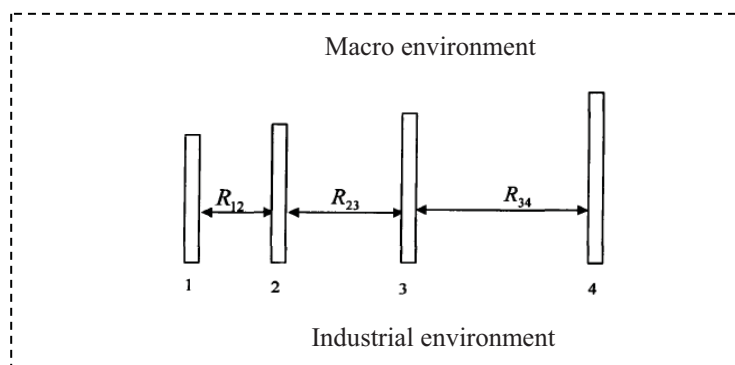


Figure 2. Domino Model of Vulnerability of Complexity System

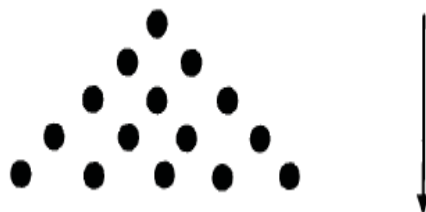


Figure 3. Pyramid Model of Vulnerability of Complexity System

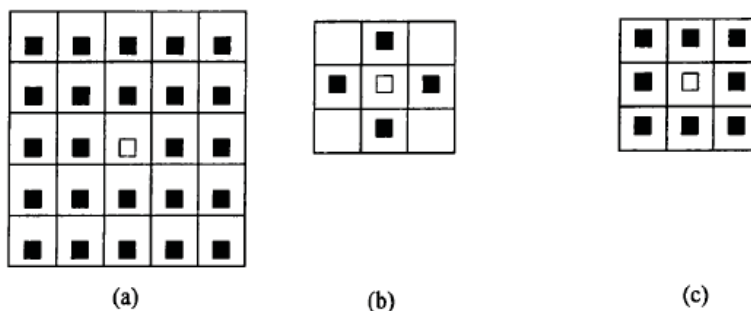


Figure 4. Two-Dimensional Cellular Automaton Model