Study on the Conflict Stability Model of Decision Makers' Behavioral Patterns and the Application

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Keywords: Behavior; Decision type; Stability; Graph model

Abstract: According to the different behaviors of decision makers in conflict, it can be divided into three types from strategic level: attack, defense and balance, and the definition of one and two steps stability of the three types of decision makers are given. The complete rationality and code of conduct symmetry are broken by this study. It allows the conflict analyst to get a better understanding of the causal relationship or a more accurate prediction the outcome of conflict. At the same time, the study expands the type of conflict stability of the classic conflict analysis for conflict resolution, and can better depict the conflict in reality. Finally, the proposed approach is employed to "Chromium pollution in Luliang County, Qujing, Yunnan" conflict. Then, model and stability analysis are established by distinguishing the different behaviors of decision makers in the conflict. The results show that different behaviors of the decision maker will have a significant impact on the final outcome of the conflict, and the method's feasibility and validity are verified. The procedure of case study can provide a decision-making reference for decision makers in strategic level.

1. Introduction

The research of conflict analysis is usually based on such a hypothesis: the entire rationality of decision makers and the symmetry of their behavioral standards. However, it is proved that this hypothesis is overestimated. The differences between the behavioral patterns of decision makers often cause the serious deviation from the ultimately obtained balance outcome.

Psychologically, any decision maker has his individual emotions in the conflicts. The emotions could be classified as positive, negative and neural. The emotional information, to a certain degree, could influence the adaptive process of the conflicts(Ma,2017). To avoid the over-hypothesis about the entire rationality of decision makers and the symmetry of their behavioral standards, the crucial factors regarding the influence of the socialized media on the decision behavior of users are studied in Li(2017). To improve the fairness of the bid evaluation, Shi(2012) offers us a new research perspective for the solution of ours social conflicts based on the continuous reciprocity theory. Regarding the specific conflicts, Hipel (1999,2014),Benet.al(2002), the leading figures in the Canadian research team of conflict analysis, put forward the concept of information gap for the description of the information asymmetry between conflict parties. Based on the information gap, the information gap model was established, and the ultimate feasible outcomes of the conflict evolution got analyzed using the graph model theory. Li et al (2004) added the factor of uncertain preferences to the decision making and provided the possible conflict outcome in the case of information gap. Yasser et al(2015) introduced free degree, probability and time series into the conflict decision making, which enriched the decision-making evidence for the decision makers in the case of non-entire rationality. The attitude analysis method was adopted to predict and analyze the development of conflicts under the combinations of different attitudes in the Walker et.al(2012), helping decision makers to understand conflicts more comprehensively and profoundly. The conflict evolution model was established using the hyper-game theory to include the situation when decision makers have wrong preferences in the Gharesifard et.al(2012). On the presupposition of

DOI: 10.25236/icecbn.2018.047

the known conflict outcome, it was reasoned in Sakakibara (2002) that what decision making information could promote the stability of the foreseen conflict outcome. From the perspective of the strategic analysis, the possible natural evolution outcome of conflicts was obtained based on Graph Model for Conflict Resolution (hereinto referred to as GMCR) in the Kinsara et.al(2012), Fang et.al(1993) and it helped people to better understand and solve conflicts.

GMCR theory is a decision-making analysis method intended for the standard modeling and analysis of conflicts. As one of the advantages, GMCR only requires the qualitative preference information of decision makers. In the conflicting issues, the less quantitative information makes it impossible for any conflict party (decision makers) to obtain the solutions of the conflicts through the quantitative game model. However, decision makers are not categorized in the current GMCR definition, so the research findings relevant to the asymmetry of decision makers' behavioral standards are relatively less. Wu et al(1985) attempted to conduct the research in this field, but they finally returned to the classical game: the quantitative preference information of decision makers. Bristow et al(2014a,2014b) introduced the competition and cooperation between decision makers into the conflict analysis for the first time and presented the advantages of GMCR in solving the asymmetry of decision makers' behavioral standards.

This paper analyzed the different behavioral patterns of decision makers in real conflicts and classified the behavioral patterns into three types: offensive, defensive and compatible. In addition, the corresponding accessible set was also defined. Next, the definitions of one-step stability and two-step stability were presented. It was revealed in the case analysis that the real world conflicts could be better described, explained or predicted in the stability research based on the behavioral patterns of different decision makers.

2. Conflicts represented through the graph model

Conflicts are represented through the graph model, including the identification of decision makers in real conflicts and their strategies and preferences; the removal of infeasible situations as well as the drawing of the graphical representation model about the state transition. The basic definition of the conflict graph model is presented as follows.

Definition 1: Graphical model is generally represented by $V=\{N,S,P,G\}$, where $N=\{1,2,\ldots,n\}$ is the set of decision makers, n is the number of decision makers, $S=\{s_1,s_2,\ldots,s_m\}$ is the feasible state set, m is the number of feasible states, $P=\{P_1,P_2,\ldots,P_n\}$ is the preference set of all the decision makers, P_i is the preference of decision makers, $G=\{G_1,G_2,\ldots,G_n\}$ is the state transition diagraph of each decision maker. In $G_i=<S, A_i>$, $i=1,2,\ldots,n$, A_i is the directed arc set of the state transition under the control of the decision maker i and the arrowhead of the arc points to the reachable state transited from the original state

Definition 2: The decision maker $i\in N$, and $R_i(s)$ is the one-step reachable state set when the decision maker i starts from the state s, which is called the reachable set.

$$R_i(s)=\{s_q\in S|(s,s_q)\in A_i\} \qquad (1)$$

$(s,s_q)\in A_i$ represents a directed arc when the decision maker i changes from the state s to the state s_q

Definition 3: In the simple preference structure $P=\{\sim_i,\succ_i\}$ of the decision maker $i\in N$ in the conflict graph model, the symbols of "$\succ$" and "$\sim$" represent the preference information of a decision maker towards different states, respectively.

Take two arbitrary feasible states: s_p , $s_q\in S$ for example, $s_p\succ_i s_q$ represents that the state s_p is superior to the state s_q for the decision maker i ; $s_q\succ_i s_p$ represents that the state s_q is superior to the state s_p for the decision maker i; $s_p\sim_i s_q$ represents that the state s_p is equal to the state s_q for the decision maker.

Definition 4: The decision maker $i \in N$, and $R_i^+(s)$ is the improved one-step reachable state set when the decision maker *i* starts from the state *s*, which is called the improved reachable set.

$$R_i^+(s)=\{s_q \in S|(s,s_q) \in A_i \ \& \ s \prec_i s_q\} \qquad (2)$$

The formula above represents the improved reachable set for the decision maker *i* starting from the state s_p.

3. Behavioral pattern stability definition of decision makers

3.1Analysis on the behavioral patterns of decision makers

The behaviors of decision makers are investigated in real conflicts and they are categorized into three types: offensive, defensive and compatible. This paper studies the set of decision makers which only involves two decision makers, namely, $N=\{i, j\}$.

Offensive behavior is a kind of hostile or destructive behavior against the opponents of the conflicts. Offensive decision makers only consider whether their behavior could cause great losses to the opponents instead of thinking about their preference changes while making decisions. This kind of decision makers is generally powerful without caring much about the opponents. They may be in a fierce opposition to the opponents. The real conflicts are abundant with such decision makers. For example, small companies often go bankrupt or are merged by large companies in the market economy competition. Before the merger and the bankruptcy of small companies, these large companies are categorized as offensive decision makers in the competition-induced conflicts. In addition, some great powers also adopt offensive measures to highlight their hegemony in the international conflicts triggered by national interests. For instance, the large powers may adopt the economic sanctions and blocks. Small countries are forced to obey; otherwise, it may cause the civil turmoil or domestic destruction.

Since offensive decision makers consider whether the decision could cause great losses to the opponents in the process of decision making, the one-step reachable set could be defined as follows.

Definition 5: For the offensive decision maker $i \in N$, $AR_i(s)$ is the one-step transition state set when the decision maker *i* starts from the state *s* , which is called the offensive reachable set.

$$AR_i(s)=\{s_q \in S|(s,s_q) \in A_i \ \& \ s \succ_i s_q\} \qquad (3)$$

The elements of the offensive reachable set $AR_i(s)$ represent the state in which the decision maker *i* could reach from *s* and also cause the preference decrease of the opponent decision makers.

Unlike the offensive decision makers, the defensive ones take an immediate action at the sight of profits instead of analyzing the benefit changes of other decision makers. Defensive decision makers are generally at a disadvantage in conflicts. Given that the strengths and influences are relatively weak, the defensive ones mainly aim to protect their own benefits and increase their profits in the conflicts. It is really typical of those enterprises that only pursue the profits in the reality. Whatever impact and pressure they face from the outside world, the profit becomes a priority for them and could mobilize all their initiatives.

Since defensive decision makers consider whether the decision could bring profits to themselves in the process of decision making, the one-step reachable set could be defined as follows.

Definition 6: For the defensive decision maker $i \in N$, $DR_i(s)$ represents the one-step transition state set when the decision maker *i* starts from the state *s* , which is called the defensive reachable set.

$$DR_i(s)=\{s_q \in S|(s,s_q) \in A_i \ \& \ s \prec_i s_q\} \qquad (4)$$

The elements of the defensive reachable set $DR_i(s)$ represent the state in which the decision maker *i* could reach from *s* and also improve their own preference state.

In actual conflicts, some decision makers cannot be simply defined as offensive ones or defensive ones. For example, regarding the relations between the local government and the enterprises which contribute greatly to the local economic development, it could be represented as follows: on the one hand, the local government hopes that the enterprises create more tax revenues and jobs; On the other hand, the local government hopes the enterprises observe the rules and regulations as well as conduct the legal operations. When enterprises operate illegally in the pursuit of profits, the government sometimes has to make concessions at the thought of public benefits. The benefits of this type of decision makers are often bound with those of the opponents, but they fail to merge into a decision maker. The compatible decision makers consider the situations comprehensively. The common profits either increase or get lost.

Since compatible decision makers face the consistent interests as the opponents in the process of decision making, the one-step reachable set could be defined as follows.

Definition 7: For the compatible decision maker $i \in N$, $CR_i(s)$ represents the one-step transition state set when the decision maker i starts from the state s, which is called the compatible reachable set.

$$CR_i(s)=\{s_q \in S|(s,s_q) \in A_i \,\&((s \prec_i s_q \,\&\, s \prec_j s_q)| (s \succ_i s_q \,\&\, s \succ_j s_q))\} \quad (5)$$

The elements of the compatible reachable set $CR_i(s)$ represent the state in which the decision maker i could reach from s and also make their own preference direction changes consistent with those of the opponents.

3.2 Correlation stability description

According to the differences of the decision makers' behavioral patterns, the following stability definitions are presented for three types of decision makers (offensive ones, defensive ones and compatible ones): the one-step stability definition without the opponent counterattack and the two-step stability definition with the opponent counterattack.

Definition 8 (one-step offensive stability)**:** Regarding the offensive decision maker $i \in N$ and the state $s \in S$, if $AR_i(s)=\varnothing$ satisfies, then the state s is called one-step offensive stability and could be recorded as $s \in S_i^{AR1}$ for the offensive decision maker i.

Definition 9 (one-step defensive stability)**:** Regarding the defensive decision maker $i \in N$ and the state $s \in S$, if $DR_i(s)=\varnothing$ satisfies, then the state s is called one-step defensive stability and could be recorded as $s \in S_i^{DR1}$ for the defensive decision maker i.

Definition 10 (one-step compatible stability)**:** Regarding the compatible decision maker $i \in N$ and the state $s \in S$, if $CR_i(s)=\varnothing$ satisfies, then the state s is called one-step compatible stability and could be recorded as $s \in S_i^{CR1}$ for the defensive decision maker i.

Definition 11 (two-step offensive stability)**:** Regarding the offensive decision maker $i \in N$ and the state $s \in S$, when at least one $s_2 \in AR_i(s_1)$/ $DR_i(s_1)$/ $CR_i(s_1)$ satisfies $s \prec_i s_2$ for the arbitrary $s_1 \in AR_i(s)$, then the state s is called two-step offensive stability and could be recorded as $s \in S_i^{AR2}$for the offensive decision maker i.

Definition 12 (two-step defensive stability)**:** Regarding the defensive decision maker $i \in N$ and the state $s \in S$, when at least one $s_2 \in AR_i(s_1)$/ $DR_i(s_1)$/ $CR_i(s_1)$ satisfies $s \succ_i s_2$ for the arbitrary $s_1 \in DR_i(s)$, then the state s is called two-step defensive stability and could be recorded as

$s \in S_i^{DR2}$ for the offensive decision maker ***i***.

Definition 13 (two-step compatible stability)**:** Regarding the compatible decision maker $i \in N$ and the state $s \in S$, when at least one $s_2 \in AR_i(s_1)$/ $DR_i(s_1)$/ $CR_i(s_1)$ exists and $(s \succ_i s_2 \ \& s \prec_j s_2) | (s \prec_i s_2 \ \& s \succ_j s_2)$ satisfies for the arbitrary $s_1 \in CR_i(s)$, then the state s is called two-step compatible stability and could be recorded as $s \in S_i^{CR2}$ for the defensive decision maker ***i***.

4. Chromium pollution conflict analysis in Luliang County, Qujing, Yunnan Province

4.1 Background description and conflict modeling

In June, 2016, an environmental pollution conflict was caused by the illegal transition and dumping of chromium slags in Luliang County, Qujing City of Yunnan Province, China. Before the conflict, the chromium slag accumulation issue has lasted for 22 years in Qujing City of Yunnan province. The local government has negotiated with the responsible enterprise---Luliang Chemical Engineering Company Limited (hereinto shortened as Luliang Chem) many times, but this problem fails to get really solved. The substantial progress fails to be achieved in this conflict until the chromium slag pollution caused the massive death of livestock and got disclosed by the media in August, 2011

Regarding the conflict, the modeling is divided into two stages: In Stage 1, the decision makers were the local government (DM1) and Luliang Chem (DM2) before the intervention of Yunnan Environmental Protection Department (hereinto referred to as Yunnan EPD in Tables). In Stage 2, the local government became the executor and the decision maker became Yunnan Environmental Protection Department (DM3) and Luliang Chem (DM2) after the intervention. Local residents, civil environmental protection organizations and the media promoted the solution of the conflict, but they failed to act as a decision maker because of lacking the decision making power.

DM1and DM3 have only one strategy:

(1)Amendment(Am): the announced environmental protection schemes are amended in response to the requirements of Luliang Chem, making the schemes easier to accept.

DM2 has three countermeasures as follows:

(2) Delay(D): DM2 kept using the delay strategy in the disposal process. No effective rectifications were made, and no effective measures were adopted to solve the pollution problems by Luliang Chem.

(3) Acceptance(Ac): DM2 accepted the national regulation scheme. It not only rectified the equipment actively but also effectively addressed the local pollution problems.

(4) Waiver(W): DM2 waived the operation rights in Luliang and filed for bankruptcy in accordance with the law.

The conflict has 2^4 states in both Stage 1 and Stage 2, namely, 16 states. After removing the illogical and infeasible states, the remaining 9 states are presented in Table 1. They are represented by s_1, s_2, … , s_9,respectively. In Table 1, “Y” means the decision maker selects the strategy, “N” means the decision maker waives the strategy, and “—” represents both “Y” and “N”. For example, the state s_9 means that whatever strategy the local government or Yunnan Environmental Protection Department adopted, Luliang Chem waived the operation rights in Luliang County. If Luliang Chem waived its operation rights, the selection of other strategies is meaningless.

Table 1 Feasibility state of chromium pollution conflict in Luliang County, Qujing, Yunnan

DMs	Scheme	Feasibility States								
		s_1	s_2	s_3	s_4	s_5	s_6	s_7	s_8	s_9
DM1/DM3	1. Am	Y	Y	Y	Y	N	N	N	N	—
DM2	2. D	N	Y	N	Y	N	Y	N	Y	—
	3. Ac	N	N	Y	Y	N	N	Y	Y	—
	4. W	N	N	N	N	N	N	N	N	Y

4.2 Stability analysis based on different behavioral patterns of decision makers

In the conflict of Stage 1, decision makers were the local government and Luliang Chem. It is obvious that the local government must fulfill the responsibilities and consider the local economic interests and employment comprehensively. Given its relations with Luliang Chem---a conflicting relationship with common interests, the local government is defined as the compatible decision maker. As an enterprise, Luliang Chem pursues the short-term profits whoever the opponents are, so it is defined as the defensive decision maker. According to the stability definition, the obtained stability results in the conflicts of Stage 1 are presented in Table 2. "√" represents that the stability or the equilibrium solution of a certain state in the corresponding definition.

Table 1 Feasibility state of chromium pollution conflict in Luliang County, Qujing, Yunnan

Table 2 stability and equilibrium solution in the conflicts of Stage 1

DMs	Stability Type	Feasibility States				
		s_1	s_2	s_3	s_4	s_5
DM1	one-step stability					√
	two-step stability	√	√	√	√	√
DM2	one-step stability			√		
	two-step stability	√	√	√		
	one-step equilibrium					
	two-step equilibrium	√	√	√		

DMs	Stability Type	Feasibility States			
		s_6	s_7	s_8	s_9
DM1	one-step stability	√	√	√	√
	two-step stability	√	√	√	√
DM2	one-step stability				√
	two-step stability				√
	one-step equilibrium				√
	two-step equilibrium				√

It could be seen in Table 2 that the local government satisfies the one-step stability in states of s_5—s_9 , but it becomes the two-step stability in all the states. The local government hoped that Luliang Chem could rectify the chromium slag pollution in accordance with the national standard rectification scheme of chromium slag pollution before the counterattack from Luliang Chem. After the counterattack from Luliang Chem, all the states were stable (two-step stability). However, the local government considered the local economic interests and bore a fluke mind that it would not cause serious conflicts, so the local government turned a blind eye towards the issue. Luliang Chem satisfied the one-step stability in states s_3 and s_9, and the corresponding conflict outcome of State 3 was presented as follows: when the local government agreed to amend the environmental protection scheme and satisfied its requirements, Luliang Chem accepted the rectification scheme without delay in order to maintain its local operation rights. s_9 was a situation without alternative options for both parties. The states of the two-step stability were s_1—s_3 and s_9. This also suggested: Luliang Chem insisted that the environmental protection scheme must be amended to satisfy its requirements when realizing the irresolute attitude of the local government. Meanwhile, Luliang Chem also thought that the local government would keep the operation rights because it created a lot of economic interests locally.

To sum up, the one-step equilibrium gets satisfied at only State s_9 in the first stage of the conflict, but the local government could barely adopt this attitude in this situation. The state s_1—s_3 gets added in the two-step equilibrium, but the local government must amend the environmental protection scheme to satisfy the requirements of Luliang Chem to achieve this equilibrium. In addition, the local government could never breach the national official documents openly. Therefore, the conflict remained in the state of "give-and-take" without achieving any substantial progress before the large-scale eruption. The conflict entered the second stage after the serious crisis was discovered by local residents and the environmental protection organizations and was reported by the media.

After the intervention of Yunnan Environmental Protection Department, the decision makers changed from the local government and Luliang Chem to Yunnan Environmental Protection Department and Luliang Chem in the second stage of the conflict. The local government acted as an executor of orders. Yunnan Environmental Protection Department is provincial and it has no interest conflicts with Luliang Chem. It aims at a thorough rectification of the local environmental pollution to return a safe living environment to local residents. Therefore, it would never make any concessions in the execution of national policies and could be categorized as the offensive decision maker. As an enterprise, Luliang Chem could be defined as the defensive decision maker for the decision-making behavioral patterns remain the same. According to the stability definition, the stability results in the second stage of the conflict are presented in Table 3.

Table 3 Stability and equilibrium solutions in the second stage of the conflict

DMs	Stability Type	Feasibility States				
		s_1	s_2	s_3	s_4	s_5
DM3	one-step stability					√
	two-step stability					√
DM2	one-step stability			√		
	two-step stability	√	√	√		
	one-step equilibrium					
	two-step equilibrium					

DMs	Stability Type	Feasibility States			
		s_6	s_7	s_8	s_9
DM3	one-step stability	√	√	√	√
	two-step stability	√	√	√	√
DM2	one-step stability				√
	two-step stability				√
	one-step equilibrium				√
	two-step equilibrium				√

It could be seen in Table 3 that Yunnan Environmental Protection Department offered the negotiation space only when Luliang accepted to make the thorough rectifications whether it was one-step stability or two-step stability. Yunnan EPD took an uncompromising attitude, but Luliang Chem still took the pursuit of the maximum economic interests as the priority. Similarly, Yunnan EPD stuck to the principles and was determined to rectify the local chromium slag pollution even this may force Luliang Chem to waive the operation rights. In the cases of one-step stability and two-step stability, the equilibrium got satisfied only at the state s_9 in the second stage of the conflict. The conflict was bound to happen and it was consistent with the final outcome of the conflict. Due to the chromium slag stacking for years, the disposal of the chromium slag pollution requires more money beyond the capability of Luliang Chem. Given the compulsory responsibilities, Luliang Chem could only file for bankruptcy and stop the illegal behavior of stacking chromium slags.

Meanwhile, the effective measures must be adopted to eliminate the damage of the dumped and stacked chromium slags to the environment. And the legal evaluation should also be conducted by the third party inspection that is entrusted by Yunnan Environmental Protection Department. In addition, Luliang Chem also needs to pay 10 million yuan for the environmental repair because the chromium slag pollution causes serious environmental losses. The compensation is used for the disposal of the chromium slag pollution and the environmental pollution of the Nanpan River and its surroundings.

5. Conclusions

This paper studied different behavioral patterns of decision makers in real conflicts. The patterns were classified into three types. In order to overcome the limitations of the quantitative preference information in the classical game theory, the graph model of conflict analysis was introduced in this paper. Based on the qualitative preference information, this paper also defined the reachable set, one-step stability and two-step stability for three different types of decision makers. This paper made a case study of real conflicts and found that the differentiation of decision makers' behavioral patterns played a decisive role in the trend of conflicts and the final outcome. The method could also be adopted to predict the future trends of the ongoing conflicts from a strategic height as well as to deeply interpret the past conflicts for the extraction of experience and lessons.

Acknowledgements

This paper was partially supported by the National Natural Science Foundation of China (71301064), The Ministry of Education Humanities and Social Sciences Planning Fund of China (18YJA630128).

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