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Strategic Analysis and Model Construction on Conflict Resolution with Action Game Theory

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Abstract

This research uses the "Participating Observation Method" to observe the interaction between manufacturer and distributor negotiation strategies, determine the preference and expectation of participants, and establish a framework for this type of research. Then it sets up the "analysis framework of negotiation strategies" between the manufacturer and the distributor based on an analysis of the respective conditions, advantages, and disadvantages of the manufacturer and distributor. Thirdly, this study sets up a reward matrix of the strategy action game between the manufacturer and the distributor. Then establishes a set of feasible "negotiation models" based on the reward matrix of the strategy game between the both parties to observe how the manufacturer and the distributor make their own bargaining decisions in the situation of information asymmetry or exterior opportunity/threat. Finally, this study establishes a "multi-agent strategy game protocol system model" to solve the conflict resulting from the self-strategizing of both parties for their own interests, and to achieve the utmost efficiency in the negotiation.
Keywords: strategy action game; conflict resolution; multi-agent

1. Introduction

The development of sales channel is based on cooperation between enterprises, despite potential conflict between them in commercial dealings. Due to differences in position and role between parties, the channel right problem derives from the agent relationship between the manufacturer and distributor, resulting in constant alternation between competition and cooperation. The manufacturer suspects that the distributor monopolizes market information, lacks brand loyalty, delays payment, and rejects the goods; correspondingly, the distributor is dissatisfied when the manufacturer frequently increases the purchase price, threatens to terminate the agent relationship, is out of stock, and delays delivery. Thus, both parties are suspicious of, and in conflict with, each other. Negotiation takes place because of conflicts in both parties' price expectations. The uncertainty of negotiations makes it difficult for both parties to arrive at an optimal decision in complex situations. Competition and cooperation always characterize the relationship between the manufacturer and distributor; conflict ultimately occurs if the manufacturer and distributor approach negotiations seeking only their own interests. The opinions of the both parties may be contrary or incompatible, thus requiring compromise. At least one party must change its position, or the conflict will remain unsolved. Thus, conflict resolution has become increasingly important in business relationships.

2. Strategy Action Game Theory

Strategy action uses strategies to change the faith, idea, or actions of others. It also restricts its own action and increases its interests. Jun and Zhili [11] argued that in a game, each participant will have the desire to control the game, except when a party is authoritative or preponderant. This control action, either in between a board or in private, is strategy action.

Credibility is the key of strategy action, and strategy action functions based on mutual confidence. Strategy action controls the rules of the game, and action sequence and original reward may change due to strategy action [8]. The primary strategy actions include three categories: commitment, threat, and promise [9]. The objective of using these three strategy actions is for a party to turn the situation to its advantage while making the other party believe the condition occurred naturally from the beginning [11].

In addition to being credible, a strategy action must be observable and irreversible. Take a manufacturer and a distributor for example. If the manufacturer does not find the decision of distributor, it cannot respond naturally, and the actions of both parties will be irrelevant. If the manufacturer has to hold a certain channel (irreversible), it will make a action and expect a response from the distributor, and then adjust its action in its interest. Therefore, the variables of strategy action are observable and irreversible [3], [7], [15]. Strategy action includes two categories [11]:

2.1 Unconditional Strategy Action

Channels dominate the market; those who control the channels maintain relative advantage. If a distributor declares its standpoint at first and indicates an observable and irreversible strategy, its action is unconditional, and the distributor will take the declared action regardless of how the cooperative manufacturer responds. If the manufacturer believes the declaration, it indicates that the declaration is credible, and the strategy action of distributor will be "commitment."

If both parties are equal in advantage and their commitment is credible, the opinion and response of the other party may change; this commitment has the innate advantage of making the other party change with the change of an independent variable. For example, Watson's minimum price strategy first serves the cooperative manufacturer and then the consumer.

2.2 Conditional Strategy Action

Conditional strategy action changes with the set objective. A distributor may bring pressure if it wishes to prevent the manufacturer from making any decision (i.e. "if you don't___I will___");. In contrast, it will give more inducement and encouragement if it wishes to attract the other party to achieve or support its expectation (i.e. "if you can___, I will be able to___"); this is a promise. In the realm of technology, threats influence the subsequent game strategy. The threat usually implies the promise, but it does not clarify directly; the subsequent promise is naturally credible if the threat is valid. The reward determines the scale of the threat and the promise; the difference is that the former provides a bad result, while the later provides a good result. If the distributor threatens the manufacturer, the encouragement to the manufacturer in the future will decrease; if the distributor creates favorable conditions to attract the manufacturer, the ultimate interest of the manufacturer will increase, and vice versa.

3. Conflict Resolution

Strategies and models of conflict resolution have become increasingly abundant in the last ten years. The strategies include random index, compromise, compulsive index, object index, case-based parameter aggregative index, object modification, combination, and relaxation [1], [6], [10].

- Random Index: This strategy can be effective and provide many answers for the existing problems if a little effort is made in the process of plan development, allowing the preferential selection of the best answer [2].
- Compromise: This is a tempered strategy for solving conflicts, which finds the value that best represents all the conflicting viewpoints. In other words, all the values in the opinion may be modified. The common manner of compromise is to adopt the mean value (naturally, this strategy only works for numerical value) [4]. If the values are not all dispersed equally, the ensuing result may contain a deviation. The pattern and median may lead to a better result in this condition, and the statistical method may be useful if the values are large.
- Compulsive Index: This strategy is similar to compromise, but is used when the agents are unalterable, and therefore have strong confidence in the problematic value or are restricted from implementation [5]. Both parties develop a new choice to accommodate the special requirements of agents.
- Object Index: This is necessary if the conflict occurs in a large variable, or if the agents do not recognize the conflict. The index occurs if the original plan is abandoned. This method may lead to many different plans in the hierarchy where the conflict occurs, and it is useful to change the system from the stable level and search for a new field [12].
- Case-based Parameter Aggregative Index: This strategy improves a parameter when there are many conflicted parameters and the evaluation on the case is much lower. The resolution is used when the conflict has a variable on an effective problem. The setting of this action is equivalent to making a separate alteration.
- Object Modification and Combination: This is the most expensive strategy, and is used when all the other methods fail, or the problem is believed to be suppressed [13]. When the mutually defined structure of an object is established, it is expected to enter a new search field [9].
- Relaxation: Some related variables should be relaxed and modified to solve certain conflicts. This strategy is applicable for low-level conflicts involving variance. The variance may be any numerical value or non-numerical value, and their value should be versatile and modifiable. There may be two answers for the relaxed conflict: variation conflict and variation compulsive conflict.

4. Strategy Game of Multi-agent Conflict Resolution

What follows is a description of the research method used in this paper, an analysis of manufacturer and distributor, the framework and game reward matrix, and the multi-agent strategy game protocol system.

4.1. Participating Observation Method

This study uses the "Participating Observation Method" in property research. The participating observation method is a kind of field observation or direct observation. The researcher will establish and maintain a long-term multidimensional relationship with the group members, thus aiding the research.

There are three practical ways to participate in the observation:

- Complete Participation: The researcher permeates the activity of the research object, becoming a part of it and interacting with it, which may be the key to changing or ending the activity.
- Research Participation: Enter into the research and participate in the relevant activity, while maintaining the identity of researcher.
- Observer: Determine from outside the condition whether the research object knows or not, while neither engaging in the activity nor intervening in any circumstances.

Complete participation is inapplicable when the commercial standpoint is different and the actual interest negotiation is involved. Thus, research participation and observation are used to collect and interpret the data and perform analysis in this study.

4.2. Strategy Action game

Manufacturer and distributor expectation and satisfaction are the most important factors for the success of bargaining negotiations; one must therefore acquire the preference and expectation of a participant to make a bargaining negotiation as a participant. This study refers to the action strategy in the strategy action game of Jun and Zhili [11]. Figure 1 shows the framework of this study.

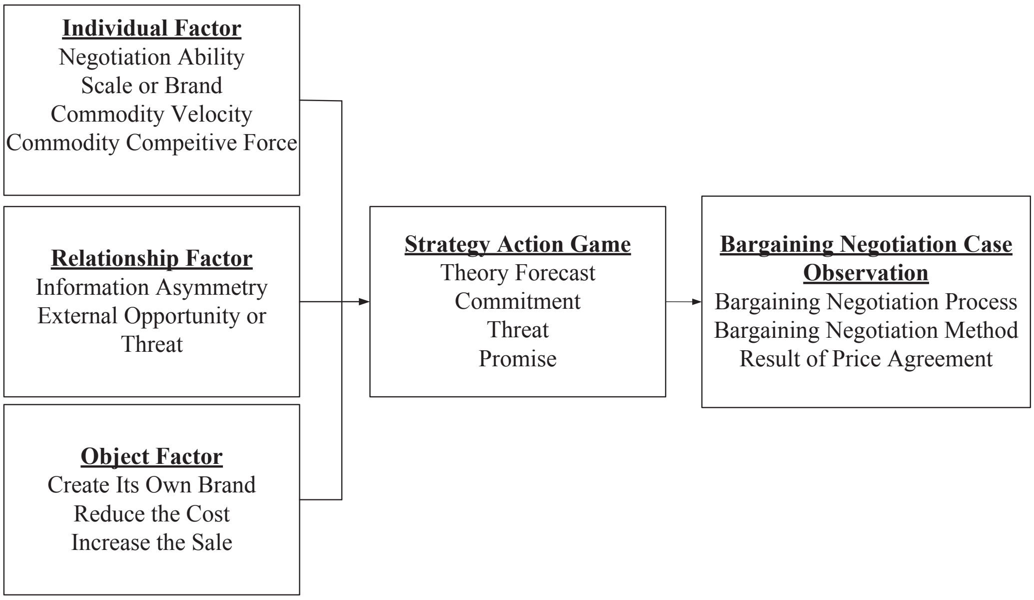

Figure 1. Research framework

4.3. Analysis on Manufacturer and Distributor

M International Co. Ltd. is a baby diaper manufacturer. The case company was founded in 1969, and initially its main operating item was cardboard man; it officially entered into the baby diapers industry in 1990. With the flourish development of the domestic consumption channel, the market ratio of the case company kept decreasing due to the strong competition of domestic and foreign products. The market ratio has stayed at approximately 5% in recent years. However, although the owner wants to recover its domain of former days, the case company has no choice but to compress the profit space and accept the terms of distributors due to the low industry entrance threshold, excessive potential competitors, and advantageous distributors. The company director thinks that in recent years the tripartite confrontation of brands has made it difficult for manufacturers to change the market ratio.

D Co. Ltd. (D Company) was founded in 1963. Its main operating businesses are pesticide, supermarkets, and western medicine. It was listed in 1989. D Company is one of the biggest pesticide manufacturers in Taiwan, and pesticide manufacturing is its core enterprise. It established a supermarket department to take advantage of the existing marketing organizations and vegetable arrangement centers of relevant departments in the company. The commodities come directly from the producing area, have set up a chain of supermarkets, and the promotion of their products' freshness with a quality guarantee. It decreases the cost by bulk stock via the logistics center, benefits the customers, and improves the competitive force. To compete with other supermarkets and variety stores, D supermarket carries out a fresh food mart vision with a freshness guarantee, introduces new products actively and provides consumers with a convenient, tidy, comfortable, and one-stop shopping environment.

D supermarket presents itself as the “fine neighbor of freshness” and as a good co-worker of family living, enabling consumers to buy the freshest and healthiest materials with the most convenience and lowest prices.

4.4. Establish the Analysis Framework of Negotiation Strategy Action

After finishing the respective objective environment analysis of distributor and manufacturer, we find that their cooperation relationship is very delicate. The distributor is welcome even if the hot commodity does not pay the slotting fee; the manufacturer expectation expands the channel or pays more money for commodity circulation. There is an affiliation between the parties, and cooperation is necessary to obtain greater profits. After an agreement expires, slotting fees and reward negotiations become typical. Figure 2 shows the analysis framework of negotiation strategy action between manufacturer and distributor. This analysis is based on the established negotiation practices between manufacturers and distributors in traditional industries and products.

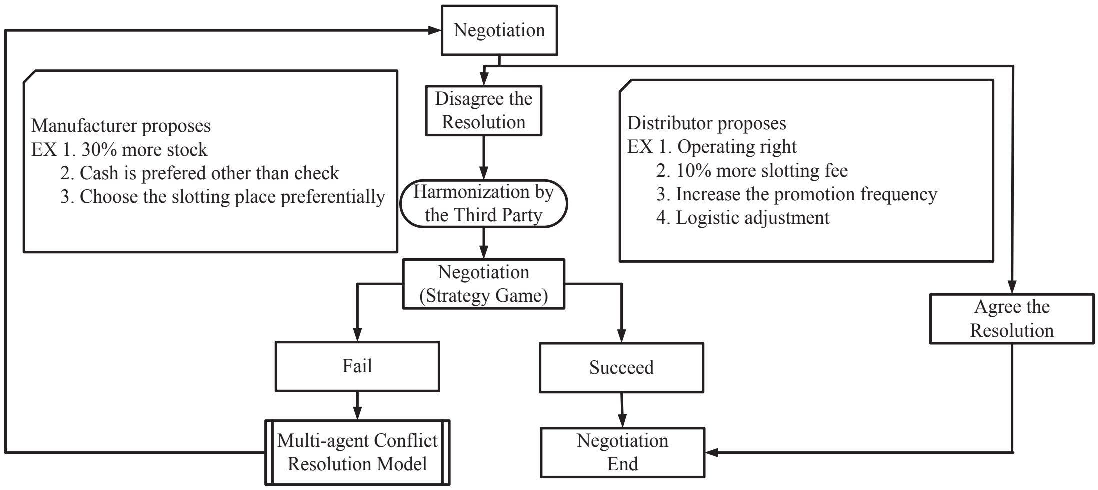

Figure 2. Analysis framework of negotiation strategy action

4.5. Establish the Game Reward Matrix of Strategy Action

In our analysis of the strategy action application of manufacturer and distributor, we use commitment, threat, and promise strategy to research the game reward matrix. For example, in the case of a threat and promise strategy action application on the slotting fee, the manufacturer expects to reduce it, while the distributor expects to increase it. The conflict occurs even though both parties have the willingness to negotiate because of a consideration of interest, and the terms brought forward by each party are very different from the expectations of the other. The distributor may propose a strategy to improve the operation, and the manufacturer may propose a strategy to increase stock 30%. If both parties accept each other’s terms, the reward will be zero for each party. In other words, they maintain their status without a chance of cooperation. The most favorable for the distributor would be that the manufacturer accepts its resolution, while it does not accept the manufacturer’s resolution, yielding a reward of 1; for the manufacturer, the most favorable outcome would be that the distributor accepts its resolution to add 30% stock, while it does not accept the distributor’s resolution, yielding a reward of 1. If both parties do not accept each other’s terms, the reward will is –2.

Table 1 shows the game reward matrix of distributor and manufacturer.

		Manufacturer	
		Accept adding the operating right	Refuse adding the operating right
Distributor	Accept adding 30% stock	0, 0	-1, 1
	Refuse adding 30% stock	1, -1	-2, -2

Table 1. Game reward matrix of distributor and manufacturer

4.6. Introduce the Multi-agent Conflict Resolution Concept into the Strategy Game

Figure 3 shows the preparation of negotiation flow. When a negotiation fails, both parties should make the next negotiation following relevant arrangements and internal protocol.

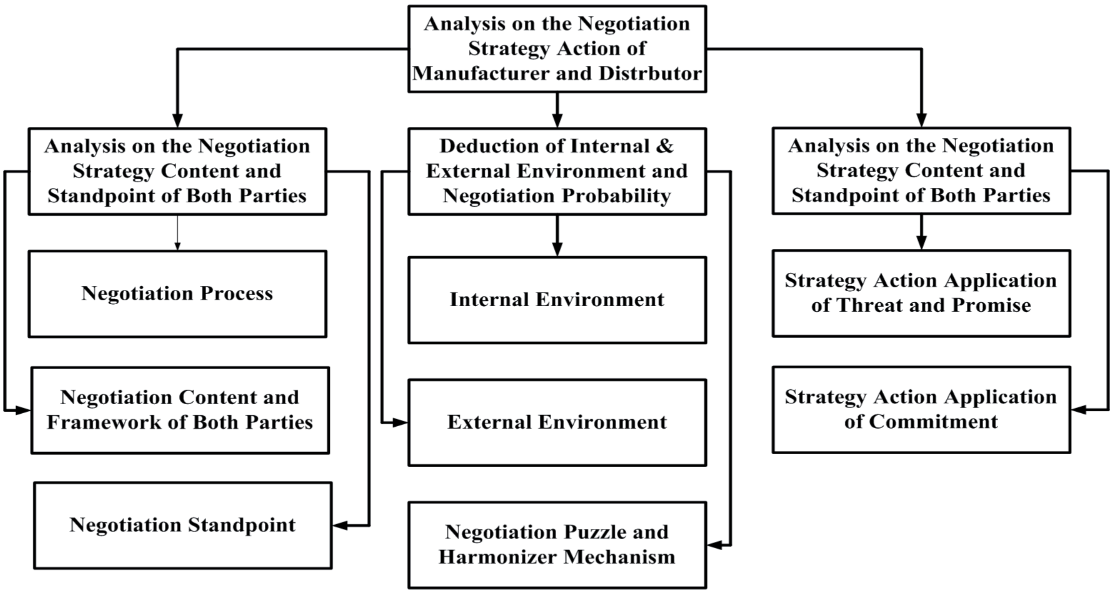

Figure 3. Negotiation flow

The researcher observes and records the practical negotiation process between the distributor and manufacturer on the spot. Making the practical negotiation operating process and the strategy action game theory reflect each other and establishes a multi-agent model to analyze and check the strategy game reward matrix in the process of negotiation. Then discusses how to maintain common sense as each party insists on its interests under the individual ration principle and information asymmetry. The premises of the multi-agent model are as follows:

(1) For the sake of analysis, the research framework supposes that the distributor and the manufacturer of the traditional industry product play a zero-sum game. The distributor is regarded as the agent D, and has two strategies: cooperative and uncooperative; the manufacturer is regarded as the agent M, and has two strategies: cooperative and uncooperative. Internal and external environments influence the negotiation standpoints of each party. Although both parties are willing to negotiate, due to the consideration of interest, the terms of each party are much different from the expectations of the other. It is at least a best game equilibrium under the premise that both parties agree to negotiate; therefore, another agent must act as the harmonizer (third party). This harmonizer,

labeled as agent C, is the conflict resolution agent required to solve the conflict. Table 2 establishes a strategy reward matrix, in which the values in the table are the reward of each strategy.

		Agent M	
		Cooperative	Uncooperative
Agent D	Cooperative	(1, 1)	(0, 0)
	Uncooperative	(0, 0)	(-2, -2)

Table 2. Strategy reward matrix

(2) Agent D and agent M share a common database, while they have their own repositories. This is because if agent D and agent M do not share a common database, agent D can access more confidential data relative to agent M, enabling agent D to make a more accurate decision than agent M for the specified problem. Therefore, the common database here means letting each agent access an opening database fairly without any restriction.

(3) Agent D and agent M have the same importance. This is because if agent D is more important than agent M is, when they deliver their opinions to agent C, the value of agent D on a specified problem might be 0.4, while that of agent M might be 0.6. In the event that the decision rule of the research is to adopt the bigger value as the decision variable, then agent C should believe the suggestion of agent M because 0.6 is bigger than 0.4. However, if agent D is more important than agent M is in an organization—for example, if agent D has more experience than agent M does—then agent C should believe the suggestion of agent D. In this case, agent C will be confused in making the decision; that is why we give this premise in the research. Figure 4 shows each assumption.

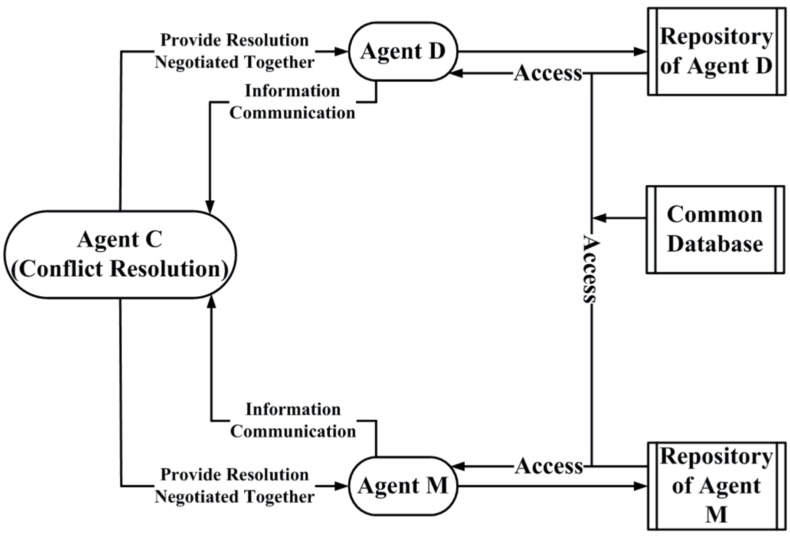

Figure 4. Multi-agent framework

(4) The agent D and agent M must be mutually independent. If they are not dependent, they will influence each other when making the decision. Agent D must refer to the value of agent M when determining its decision variable, and agent M also must refer to that of agent D when determining its decision variable. The conflict resolution process will be more complex in this condition.

4.7. Establish Multi-agent Strategy Game Protocol System

Figure 5 shows the steps for establishing the multi-agent strategy game protocol system:

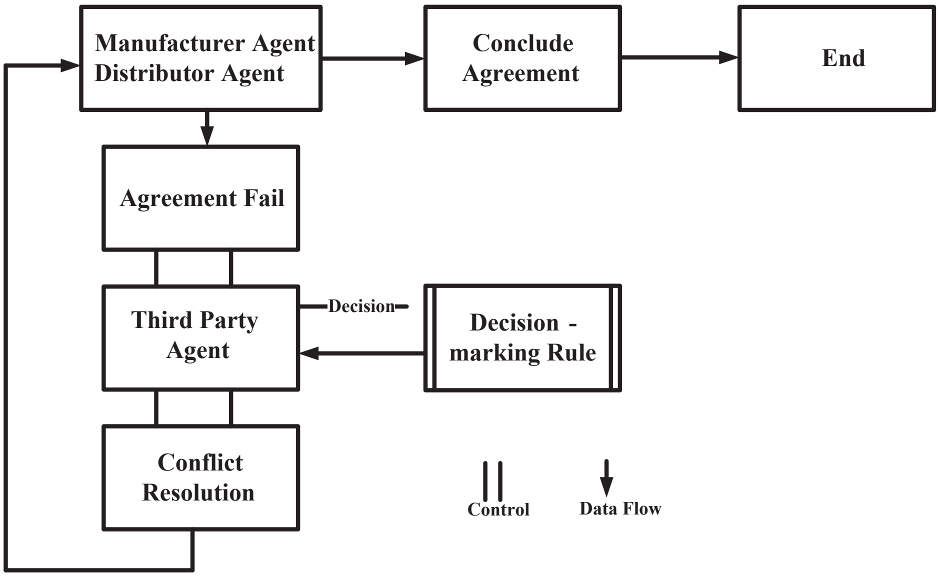

Figure 5. Multi-agent strategy game protocol system model

(1) Design third party agent mechanisms; the manufacturer agent, distributor agent, and the third party agent represent the harmonization mechanism between the both parties and the third party.
(2) Resolve the strategy reward value of each party under the individual requirement restriction.
(3) The manufacturer agent and the distributor agent send the strategy reward value to the third party agent at the same time.
(4) The third party agent judges whether the received strategy reward values conflict with each other.
(5) If conflict occurs, the third party agent should select the resolution rule in the decision-making rule database, implement the conflict resolution, send back the result to the manufacturer agent and distributor agent, and then judge whether the individual requirement has been satisfied.
(6) If the result from the conflict resolution implemented by the third party agent cannot satisfy the individual requirement of any agent, another resolution rule will be selected from the decision-making rule database, and the conflict resolution will be implemented to produce another new result. This procedure will continue until the result can satisfy the requirements of all the agents.

5. Development of Strategy

This research's mediation strategy defines the role as two persons who could adopt a strategy according to their company's practical situation. Figure 6 shows the practical operation steps. The descriptions are as follows:

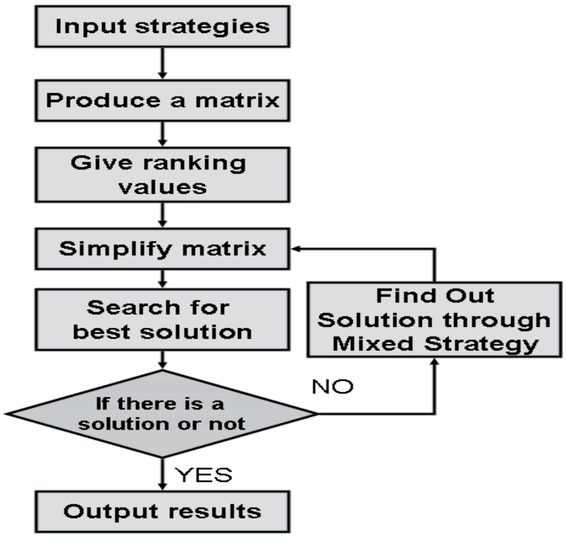

Figure 6. Flow chart of operations to find solution

Step 1. Both companies enter all the strategies that will be adopted and open to the public in cooperation with the other company. It is not necessary to enter the strategies' expected reward values.

Step 2. The system will produce an m * n reward matrix (hereafter called Matrix Z1) according to the number of strategy both parties have entered. Suppose there are two companies—Company D and Company M. M represents the number of strategies Company D wants to adopt, and n represents the number of strategies Company M wants to adopt. At this point, the matrix includes any reward it has, and the system automatically produces all corresponding strategy combinations.

		M			
		M-1	M-2	…	M-n
D	D-1				
	D-2				
	…				
	D-m				

Table 3. System produces automatically initial reward matrix Z1

Step 3. The system sends back all strategy combinations that it has automatically produced for Company D and Company M. The two parties arrange a sequence of all strategy combinations according to their situations and give ranking values from highest to lowest. Each party judges which strategy combination will benefit their company the most and assigns it the highest-ranking value for that judgment and conversely, if the strategy combination is not beneficial or even detrimental to their company, they will give it a lower ranking value. Both companies conduct the judgment securing maximum reward as their goal. In short, in this step both companies arrange the order of benefit degrees for all strategy combinations.

Step 4. Fill out all corresponding columns in the Z1 Matrix with the row values of Step 3. Produce a two-person multi-strategy game reward matrix (hereafter called Z2) with reward values (please refer to Table 4). Then conduct a domination strategy judgment on the Z2 Matrix. In the reward matrix of game theory, if there is any dominating strategy (it is always better for a party to adopt one strategy over another), then a party should first conduct matrix simplification. Continuing is possible only after simplifying a matrix (hereafter called Z3).

		M			
		M-1	M-2	…	M-n
D	D-1	(Pd1, Pm1)	(Pd2, Pm2)	…	(Pdn, Pmn)
	D-2	(Pd(n+1), Pm(n+1))	(Pd (n+2), Pm(n+2))	…	(Pd2n, Pm2n)
	…	…	…	…	…
	D-m	(Pd((m-1)n+1), Pm((m-1)n+1))	(Pd((m-1)n+2), Pm((m-1)n+2))	…	(Pdmn, Pmmn)

(*Pa1~Pamn：Represent the given value of row of various strategy combination for D Company, Pb1~Pbmn：Represent the given value of row of various strategy combination for M Company*)

Table 4. Reward Matrix Z2

Step 5. Starting from the maximum reward value, confirm if Company D chooses the strategy with the maximum reward value, and whether Company M could secure the maximum reward value by adopting the responding strategy. If the answer is yes, the strategy combination possesses an equilibrium of solutions; if not, Company M should adopt a strategy with a larger reward value. Then in the same way, Company D must confirm that the strategy combination is the responding strategy that could secure the maximum reward. If the answer is yes, the strategy combination possesses an equilibrium of solutions; if not, Company D should adopt a strategy with a larger reward value. This process continues until finding an equilibrium solution.

Step 6. If such a method of searching for optimal solutions does not yield an equilibrium solution, the system will continue to repeat the cycle of strategy combinations. At this point, the system will adopt a mixed strategy in game theory to find a solution. If a reward matrix leaves two strategies for Company D and also two strategies for Company M, then the Reward Matrix Z3 after simplification is as follows in Table 5:

		M	
		M-1	M-2
D	D-1	(Pd1, Pm1)	(Pd2, Pm2)
	D-2	(Pd3, Pm3)	(Pd4, Pm4)

(*D-1~2: Represent two strategy options remaining for Company D; M-1~2: Represent two strategy options remaining for Company M; Pd1~d4: Represent the reward value corresponding to Company M's perceived strategy combination; Pm1~m4: Represent the reward value corresponding to Company M's perceived strategy combination*)

Table 5. Reward Matrix Z3

Then divide Company D's and Company M's corresponding reward matrix into Za and Zb reward matrices.

For Matrix Za, the calculation of mixed strategy [14] is as follows:

Calculation 1. Conduct domination strategy judgment first. If the judgment can produce a mediation equilibrium solution, send back directly the strategy used by the equilibrium solution. If the judgment cannot produce an equilibrium solution and is an indefinite cycle, then proceed with the following actions.

Calculation 2. According to the maximum and minimum theory, the attacking side (on the left side of reward matrix, representing D) can find the maximum expected benefit in the minimum reward options (hereafter called Max-d) whereas the defense side (on the upper side, representing M) can find the minimum expected loss in the maximum loss options (hereafter called Min-m).

Calculation 3. The left side of mixed strategy is the attacking side (*find expected benefit*); the upper side is defense side (*find expected loss*).

A: Assume Company M chooses Strategy M-1 ➔ the probability of responding with Strategy D-1 is p1, and the probability of responding with Strategy D-2 is (1-p1).

$$EG(D) = P_{d1} \times p1 + P_{d3} \times (1 - p1) \quad (1)$$

Assume Company M chooses Strategy M-2 ➔ the probability of responding with Strategy D-1 is p1, and the probability of responding with Strategy D-2 is (1-p1).

$$EG(D) = P_{d2} \times p1 + P_{d4} \times (1 - p1) \quad (2)$$

Through (1) and (2), we could find the probability p.

So the expected benefit of Company D is: M-1 ：EG(D) = (1)，M-2 ：EG(D) = (2)

If (1), (2) > Max-a, it means that adopting a mixed strategy will lead to a higher expected benefit, which is why the attacking side adopts a mixed strategy to find a solution. Then the attacking side and defense side exchange for the convenience of calculation.

B: Assume Company D chooses D-1Strategy ➔ the probability of responding M-1 Strategy is p2, and probability of responding M-2 is (1-p2).

$$EL(M) = P_{d1} \times p2 + P_{d2} \times (1 - p2) \quad (3)$$

Assume Company D chooses D-2 Strategy➔ the probability of responding M-1 Strategy is p2, and probability of responding M-2 is (1-p2).

$$EL(M) = P_{d3} \times p2 + P_{d4} \times (1 - p2) \quad (4)$$

Through (3) and (4), we could find the probability p.

So the expected loss of Company M is: D-1 ：EL(M) = (3)，D-2 ：EL(M) = (4)

If (3), (4) < Max-a, then adopting mixed strategy will result in lower loss, which is why the defense side adopts a mixed strategy to find a solution.

Finally, the system sends back the highest probability of strategy options, with the highest probability (for example, the probability "0.6" of D-1 means that if the game repeats 10 times, there will be six opportunities to adopt the D-1 strategy). If two strategies have the same probability, then the system sends back both strategies. Likewise, for Matrix Zb, the system conducts the same calculation of mixed strategies and sends back the strategy options (with the probability) of the maximum probability. If two strategies have the same probability, the system again sends back both strategies.

Step 7. The system conducts the simplification of Matrix Z3 in the strategy options sent back with the values of probability, reserving the strategy options that it has sent back and ruling out strategy options that it has not sent back. The system will produce the following three results.

Result 1. The system produces an equilibrium solution. For both parties, the simplified matrix leaves only the last strategy option. The strategy combination output is an optimal solution.

Result 2. One party leaves one strategy option and the other party leaves two-strategy options. At this point, the party leaving two strategy options will obtain a higher reward and then output the strategy combination it adopts. This strategy combination is the optimal solution.

Result 3. Both parties keep two strategy options—that is, there is no change in Matrix Z3. Calculate the probability values of both parties' strategy options and determine the probability value of each strategy option. Reserve the strategy options that have larger probability value in two options of each of both parties before output the strategy combination as an optimal solution.

Although the mixed game solution is not the real equilibrium solution for the game, could the process can show both parties which strategy option has better probability for maximum reward. Therefore, the solution in Step 7 is "the proposed strategy combination most probable to yield the players an expected maximum reward."

6. Numerical Simulation

Taking the manufacturer (M International Company, Ltd) and distributor (D Company, Ltd.) in the study as examples:

Step 1: Input the strategy that both parties want to adopt.

In this example, there are two strategies for each party to explore.
Manufacturer (M):
(M-1) Increase stocking amount by 30%
(M-2) Request priority positions on shelves for their goods
Distributor (D):
(D-1) Share operation rights with the manufacturer
(D-2) Adjust stocking cycle

Step 2: Put two strategies for each party into the reward matrix of the first stage.

Here is a code representing the matrix. D represents the distributor and M represents the manufacturer.

Step 3：Give an estimated expected reward value (replaced by ranking values, the left side of the matrix is composed of the distributor's reward values, whereas the upper side is composed of the manufacturer's reward values; refer to Table 3) according to strategies and responding strategies adopted by both parties.

This paper does this to prevent too excessive differences between a strong company and weak company that would lead to the neglect of the weak side. It then checks if there is a domination strategy before simplifying the matrix (no domination strategy in the example).

		M	
		M-1	M-2
D	D-1	(3,1)	(2,3)
	D-2	(1,4)	(4,2)

Table 6. The initial reward matrix

Step 4：Start with the maximum value of D and find the optimal solution acceptable to both parties. Continue to do this until find an equilibrium solution accepted by both parties, or produce a repeated cycle.

(1) The maximum of D will emerge when D adopts the D-2 strategy and M responds by adopting the M-2 strategy. At this point, M will find out if they could secure the maximum benefit when they respond with the M-2 strategy to D's D-2 strategy. However, the matrix shows that they could secure a higher reward value if they respond with the M-1 strategy.

(2) Repeating the action, D might choose a strategy, M respond with a strategy, M change the strategy and replace it with a different strategy that will enable it to secure a higher benefit, and D respond to the strategy. A responding route of strategy choice is produced as follows (one side adopts a strategy and expects the other side to respond with a strategy) [2]: D-2『M-2』=> M-1『D-2』=> D-1『M-1』=> M-2『D-1』=> D-2『M-2』=> M-1『D-2』…

(3) As the route emerges in the above-mentioned process of finding a solution, it has to adopt a mixed strategy to find the solution, and the game will produce a fixed cycle route as follows: D-2『M-2』=> M-1『D-2』=> D-1『M-1』=> M-2『D-1』

Step 5: Dissolve the reward matrixes of D and M.

Both parties use their own estimated reward values as the values in the reward matrixes to find a solution with mixed strategies (Table 7). Here it uses the part of distributor as an example.

		M	
		M-1	M-2
D	D-1	3	2
	D-2	1	4

Table 7. Expected reward matrix of distributor

(1) The left side of the mixed strategy is the attacking side (find out expected benefit), the upper side is the defense side (find expected loss):

D: Assume M chooses the M-1 Strategy☐

The probability of responding with the D-1 strategy is p, and with the D-2, strategy is 1-p.

$3p + 1(1 - p) = 1 + 2p$

Assume M chooses the M-2 strategy ☐

The probability of responding with the D-1strategy is p, and with the D-2, strategy is 1-p.

$2p + 4(1 - p) = 4 - 2p$

We can find $1 + 2p = 4 - 2p$ ☐ $4p = 3$ ☐ $p = 75\%$

The expected benefit of D is:

M-1: $EG(D) = 3 \times 0.75 + 1 \times 0.25 = 2.5$ (5)

M-2: $EG(D) = 2 \times 0.75 + 4 \times 0.25 = 2.5$ (6)

(2) After exchanging the roles of both parties, it is possible to figure out the expected loss of M and the probability of the response strategy by M:

M: Assume D chooses the D-1 strategy ☐

The probability of responding with the M-1strategy is p, and with the M-2 strategy is 1-p.

$3p + 2(1 - p) = 2 + p$

Assume D chooses D-2 strategy ☐

The probability of responding with the M-1strategy is p, and with the M-2 strategy is 1-p.

$1p + 4(1 - p) = 4 - 3p$

We can find out $2 + p = 4 - 3p$ ☐ $4p = 2$ ☐ $p=50\%$

The expected loss of M is:

D-1: $EL(M) = 3 \times 0.5 + 2 \times 0.5 = 2.5$ (7)

D-2: $EL(M) = 1 \times 0.5 + 4 \times 0.5 = 2.5$ (8)

(3) Use the ordinary method to find the solution to the matrix, adopt the max-min theory to determine expected loss and expected benefit, and then compare with the values of a mixed strategy: Distributor D (the attacking side) adopts the principle of selecting the bigger one over the small ones, anticipating a maximum reward with minimum benefits. They will therefore obtain a reward value of 2. However, if D adopts a mixed strategy to fin a solution, then the expected reward value could increase to 2.5. Therefore, distributor D should adopt a mixed strategy to find a solution.

(4) Manufacturer M (the defense side) adopts the principle of selecting the smaller one over the big ones, expecting minimum loss in a situation of maximum losses. They will obtain a loss value of 3. If M adopts a mixed strategy to find a solution, the expected loss could decrease to 2.5. Therefore, manufacturer M should adopt a mixed strategy to find a solution.

(5) What follows is a summary of the results of both parties' strategy calculations and a reorganization of each probability adopting various strategies by both parties: The probability for D to choose D-1 is 75% and D-2 is 25%; the probability for M to choose M-1 is 50% and M-2 is 50% (as Fig. 7 shows). Therefore, the strategy combination with the highest probability (in which both parties think it could secure higher benefit for them) is that D adopts the D-1 strategy and M adopts the M-1 strategy.

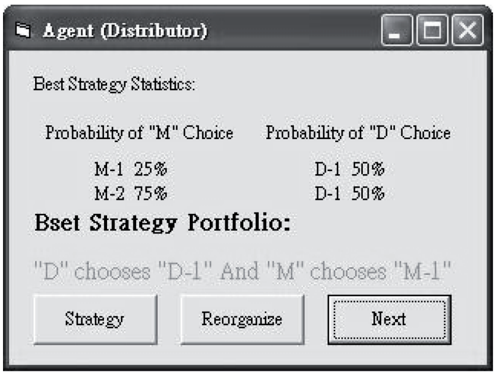

Figure 7. Distributor agent initial result

(6) Under the same condition, it is possible to use the reward values set by M to figure out a strategy combination and solution acceptable to both parties. The probability for M to select M-1 is 25% and M-2 is 75%; the probability for D to choose D-1 is 50% and D-2 is 50% (as Fig. 8 shows). Therefore, the strategy combination with the highest probability (in which both parties think it could secure a higher benefit for them) is when D adopts the D-1 strategy and M adopts the M-2 strategy.

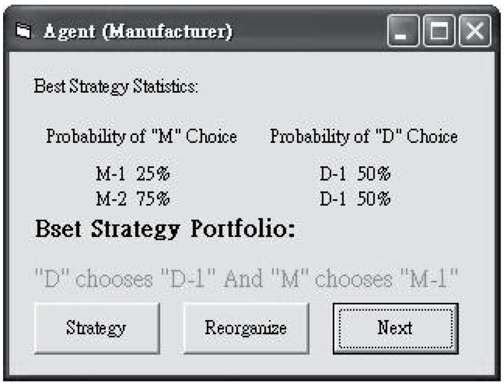

Figure 8. Manufacturer agent initial result

Step 6：Reorganize the above results and simplify the matrix in Step 3 (please refer to Table 8):

		M
		M-2
D	D-1	(2,3)

Table 8. The Final Reward Matrix

Finally, this paper considers only the strategy of M and not the strategy choice of D, because for D, the D-1 strategy is a better strategy choice and can secure a higher reward. Therefore, in the final strategy combination, D adopts the D-1 strategy and M adopts the M-2 strategy (as Fig. 9 shows).

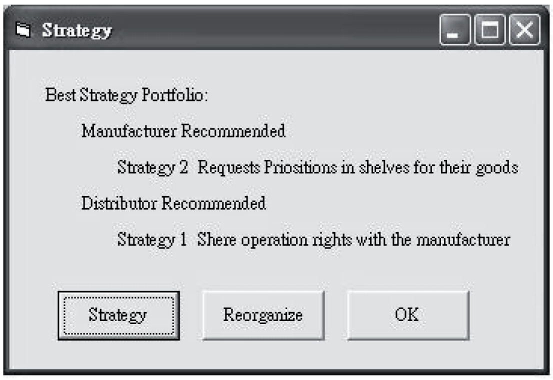

Figure 9. Final result produced from the system

7. Result and Discussion

The Cooperative Strategy for Multi-agent System Model introduced in this study quickly and automatically found the strategy combination. Both parties can secure the maximum reward through multi-agents under different situations and conditions. The information about strategy could be made public to the maximum extent. Not every player in the game has the same conditions, there is a strong and a weak one that often leads to the collapse of the game (unable to find the Nash Equilibrium in which both parties secure the same reward). For the mediation of conflicts between the strategies of both parties, the Cooperative Strategy for Multi-agent System Model offers a strategy option in which both parties can expect the maximum reward. For the example in this study, the situation in which the mediation could not produce a Nash Equilibrium solution is an indefinite cycle. However, the model that this study introduces could produce a strategy combination acceptable to both parties. The expected reward is 2 if the attacking side in the combination adopts the principle of selecting the bigger one over the small ones, whereas the expected reward of the strategy combination is 2.5. Therefore, distributor D wants to adopt a mixed strategy to find a solution. From the perspective of manufacturer M, the expected loss is 3 if the defense side has to adopt the principle of selecting the small one over the bigger ones, whereas the expected loss of the strategy combination is 2.5. Therefore, manufacturer M will be pleased to accept the strategy option. This point marks the achievement of the final goal of the conflict resolution of strategies.

8. Conclusion

This study provides a case discussion and attempts to integrate and validate the application of the theory model, and advises future research. The strategy action game is not only applicable in the field of commercial negotiation; subsequent research can extend further into the fields of education and society. The competition and cooperation relationship between manufacturer and distributor in other applications are delicate, allowing room for other methods besides strategy action game, such as series bargaining game and mean difference. This study performs the analysis aiming at the strategy application, and intervenes into the negotiation harmonization with the manufacturer or distributor. On one hand, it insists on an objective observation attitude; on the other, it may also produce the deviation of unscrambling the behavior of game participants subjectively.

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