

AGENT BASED SIMULATION OF NEGOTIATION PROCESS USING DRAMA THEORY

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Abstract

This paper develops an agent based model of dynamic negotiation among agents using drama theory and applies it in Citarum river basin problem. In the past, Citarum was a clean river where local people enjoyed fishing and recreation, however now its condition has already changed totally. Currently, the river can not provide its social services, such as clean water, electricity, fishing, tourisms, transportation, and public recreation. Classical problems always raise, there are flood when rainy season and drought when dry season. In rainy season, the color of river is brown because each drop contains mud from bald lands erosion along the river. In dry season, the color of river is black and full of household wastes. There are some factors which cause the problem, *i.e.*; illegal lodging and the population exploding in upper stream, pollution from industries in down stream, etc. *First*, this paper proposes a simulation model of negotiation based on drama theory for Citarum River basin Problem, involving local governments and people in up and down streams and an environmental NGO as agents. *Then*, this paper analyzes the interaction among the agents, and tries to describe how the conflict can change by simulation of the model. *Finally*, based on simulation results, this paper shows that positive emotional of agents affect their negotiations which could be reducing number of dilemma in Citarum river basin problem.

Keywords: Agent-based Modeling, Confrontation, Negotiation, Dilemma, Drama Theory, Emotion, Negotiation

1. Introduction

Conflict is a part of human life in this real world and agents in the situation may have dilemmas that impede the resolution. This paper proposes Citarum River Basin problem in Bandung to illustrate how the conflict changes and how dilemmas of agents in the situation decreases by simulating it with SOARS.

Citarum River basin is a region with 6,080 km² area in the three provinces, *i.e.*, West Java, Banten and Jakarta. In the past, Citarum was a clean river where local people enjoyed fishing and recreation, however now its condition has already changed totally. Currently, the river can not provide its social services, such as clean water, electricity, fishing, tourisms, transportation, and public recreation. In rainy season, the color of river is brown because each drop contains mud from bald lands erosion along the river. In dry season, the color of river is black and full of household wastes.

There are some causes of the problem, such as illegal lodging and deforestation in upper streams river. Household waste also decreases the quality of Citarum. Nowadays, at least 200 tons of household wastes are thrown away into Citarum. And also, many of industries do not perform waste treatment before throwing them away into Citarum (Pikiran Rakyat, April 17th 2005). Lack of coordination among local governments in upper and down streams area also makes the Citarum becomes worse and worse.

In spite of many seminars were held to discuss solutions for Citarum Problem, Citarum is still in bad condition even it becomes worse and worse. This paper tries to see the Citarum problem from a different point of view, starting from the belief that if stakeholders in the Citarum problem collaborate to solve the problem, then Citarum will be better and better in the future. Stakeholders in the Citarum problem have a different option with another and they can negotiate. For each agent who have dilemma with other agent will negotiate based on its strategy and emotional state (positive or negative emotion).

Agent Based Simulation of Negotiation Process Using Drama Theory

The positive emotion means that the agents want to make compromises; otherwise negative emotion means that the agent is not compromise.

In order to analyze the dynamic of conflict among participants, we use agent based modeling simulation based on drama theory. The objective of this research is to simulate and analyze the interaction among the agents which involve strategies and emotion through negotiation process. In this process, dilemma of each agent can be reduced or not depend on the strategy and emotion of each agent. What scenario which can reduce a dilemma in Citarum river basin problem? We would like to answer this question with simulation by using SOARS.

2. Citarum River Basin Problem

There are agents who participate in Citarum river basin, i.e. local people in downstream, local people in upstream, textile industries, environmentalist (green), regencies in upper stream and cities in down stream.

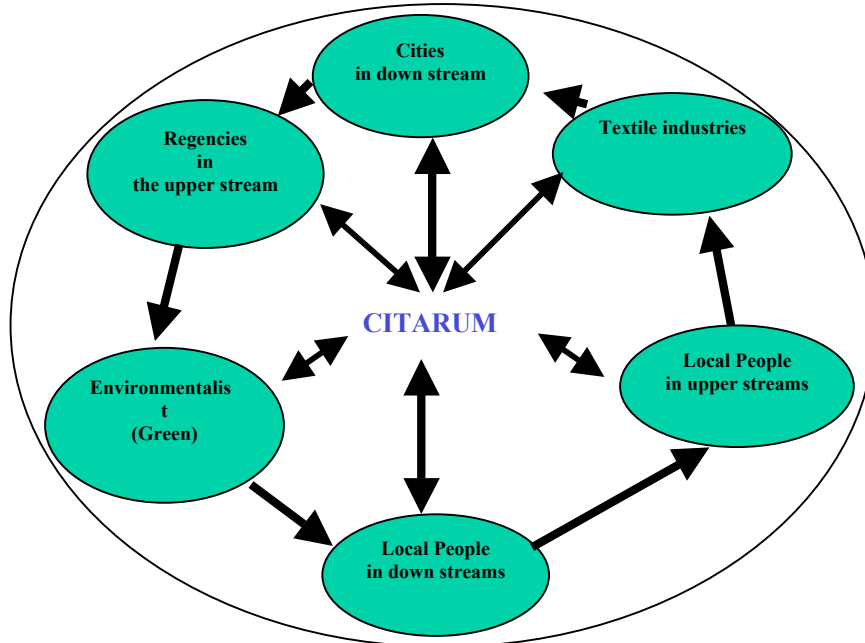


Figure 1. Agent in Citarum River Basin Problem

Each of agents in the above figure *pursues its own purposes*. They have partial proposal for the problem, for example if stop deforestation then upper local government was not happy; if stop illegal lodging then local people in upstream was not happy; if government was authoritarian then the community was not happy; if upstream was act self interest then people in downstream was suffered; if we blamed industries then there were unemployment, etc. So far, *partial proposals for the problems could not change confrontation into collaboration*.

3. Drama Theory in Citarum River Basin Problem

Different from Game Theory, Drama Theory focuses on how the conflict happens during pre-play game can change because of the parties want to *eliminate dilemmas using positive or negative emotions*. Drama theory can explain *how an irrational behavior arises*. Briefly, drama theory depicts human interaction as involving ‘characters’ each seeking simultaneously to have others adopts their ‘positions’ in collaborative situations. The dilemmas represent the challenges that each party seeks to overcome either to manage conflict and establish a shared solution, or to manage dilemmas they faced in characteristic and repeatable ways. This research will analyze the human interaction between them and to describe how that conflict is change to cooperate and then we simulate it with agent based modeling. By using drama theory, this paper explains the dynamic conflict in Citarum river basin problem.

Agent Based Simulation of Negotiation Process Using Drama Theory

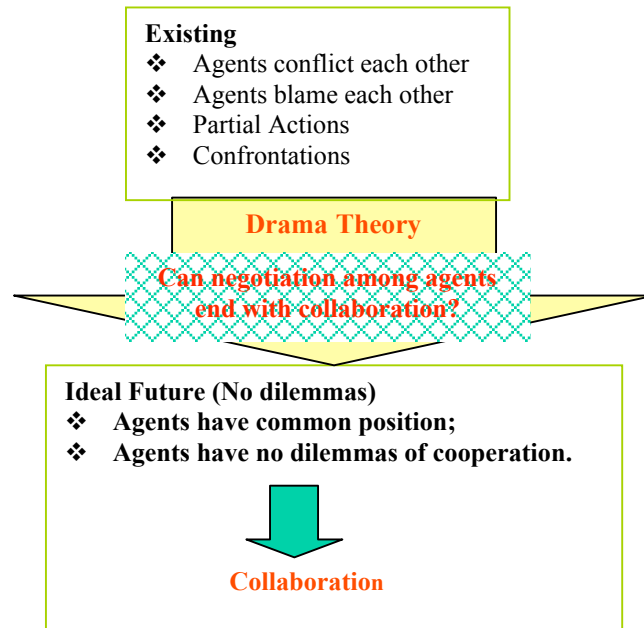


Figure 2. Transformation system using Drama Theory

Each agent in Citarum river basin has own purposes and has several frames for the situation. In Drama theory it called a *Scene setting stage*. The next stage is *Build up* to produce a common reference frame. In the climax stage will result dilemmas of agents, if the positions are not united and trustworthy, then it will return to build up stage. But if the position are united then will result resolution, it means that the conflict has resolved. The last stage is denouncement which produces collaboration or tragedy. In this paper we use drama theory and agent based simulation model for Citarum river basin problem to reduce dilemma at each agents who participate in this problem.

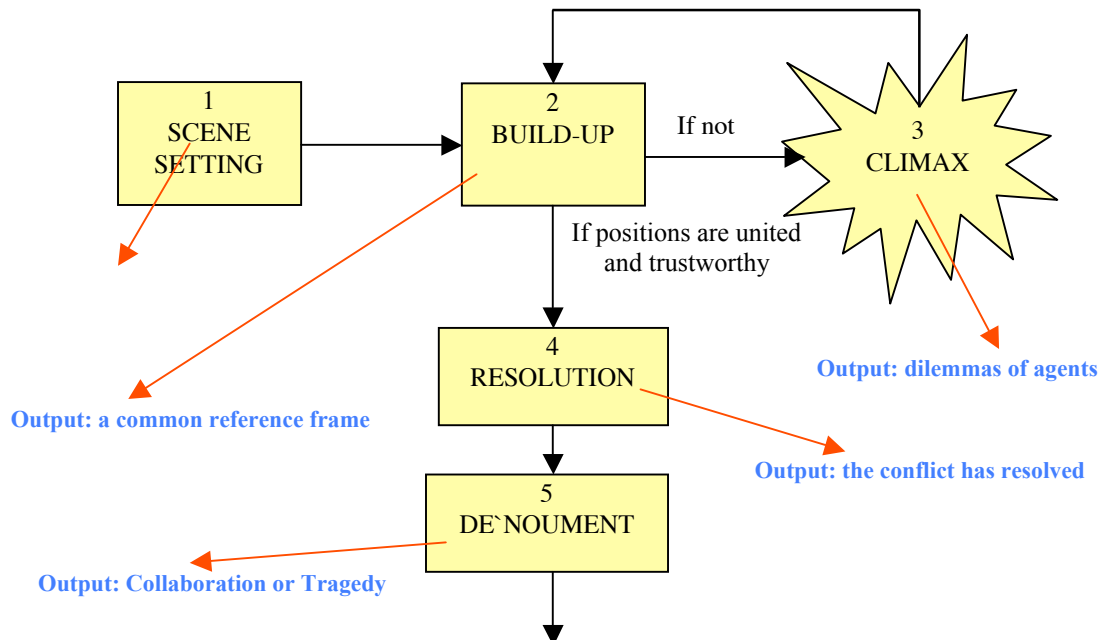


Figure 3. Drama metaphors for the dynamic of conflict (Howard, 1996)

The followings are common reference model for Citarum River basin problem, i.e.:

1. Up stream regencies has the option to stop deforestation.
2. Green (NGO) has the option to make protest
3. Textile Industry has the option to stop un treatment waste disposal
4. Down stream people has the option to stop household waste disposal
5. Up stream people has the option to stop illegal lodging

Agent Based Simulation of Negotiation Process Using Drama Theory

6. Down stream cities has the option to strict waste disposal, maintenance and revenue sharing.

OPTIONS OF PARTICIPANTS	THREAT	POSITIONS					
		USR	G	TI	DSP	USP	DSC
Up Stream Regencies						<	<
Stop deforestation	No	Yes	Yes	Yes/No	Yes	No	Yes
Green				>	<	>	<
Protest	Yes	No	No	No	Yes/No	No	No
Textile Industries			>		>		>
Stop un-treatment waste disposal to river	No	Yes/No	Yes	No	Yes	Yes/No	Yes
Down Stream People			<	<		<	<
Stop waste disposal to river	No	Yes/No	Yes	Yes/No	No	Yes/No	Yes
Up Stream People		>	>		>		>
Stop illegal lodging	No	Yes	Yes	Yes/No	Yes	No	Yes
Down Stream Cities		>	<	>	<	>	
Strict penalties for illegal waste disposal to river	Yes	Yes/No	Yes	No	No	Yes/No	No
Maintenance down Stream River	No	Yes/No	Yes	Yes/No	Yes	Yes/No	No
Revenue sharing to Up Stream Regencies	No	Yes	Yes/ No	Yes/No	Yes/No	Yes/No	No

Figure 4. Common Reference Frame for Citarum River Basin Problem

4. Model Simulation in Drama Theory

To bring a drama theory problem into simulation, then we need some definition which deals with framework of problem. In this simulation model, we assume that the first stage of drama theory is that scene setting was passed. Each agent was giving some option so it can be chosen by another agent and it open for each agent. This simulation model will perform a framework and dilemma which appeared from this framework.

Definition 1:

o_{ki} is option for agent i which can be offered to other agent, where k is number option for agent i . For each option k which owned by agent i , agent i could have an option to accept or reject for each time t .

Definition 2:

$c_{ki}^t : o_{ki} \rightarrow \{accepted, rejected\}$ is option which had been done by agent i to option k at time t . Acceptation or rejection for option k which had chosen by agent i based on value by agent i at time t for accept option or reject the option k .

Definition 3:

$Vo_{ki}^t : c_{ki}^t(o_{ki}) \rightarrow \Re$ is value to option k by agent i at time t , that is

Agent Based Simulation of Negotiation Process Using Drama Theory

$$Vo_{ki}^t(c_{ki}^t(o_{ki})) = \begin{cases} a; & \text{jika } c_{ki}^t(o_{ki}) \text{ accepted} \\ x-a; & \text{jika } c_{ki}^t(o_{ki}) \text{ rejected} \end{cases}$$

x is basic value.

For each option k which had offered by agent i , agent j give the choice to that option, which is rejected, accepted, or abstain (not choose) at time t .

Definition 4:

$c_{kij}^t : o_{kij} \rightarrow \{accepted, rejected, abstain\}$ is option from agent i to option k which had owned by agent j at time t .

Acceptation or rejection which had been done by agent i to option k which offered by agent j was based on perception value from agent i at time t .

Definition 5:

$Vpo_{kij}^t : c_{kij}^t(o_{kij}) \rightarrow \mathfrak{R}$ is value of option perception from agent i to option k which offered by agent j at time t that is

$$Vpo_{kij}^t(c_{kij}^t(o_{kij})) = \begin{cases} a; & \text{jika } c_{kij}^t(o_{kij}) \text{ accepted} \\ x-a; & \text{jika } c_{kij}^t(o_{kij}) \text{ rejected} \end{cases}$$

x is basic value.

or

$$Vpo_{kij}^t(c_{kij}^t(o_{kij})) = 0; \quad \text{jika } c_{kij}^t(o_{kij}) \text{ not be chosen}$$

Agent i have the position for option that had been chosen at time t , that is

$$p^t = \{p_1^t, p_2^t, p_3^t, \dots, p_n^t\} \quad n = \text{number of agent}$$

with

$$p_i^t = \{c_{ki}^t(o_{ki})\} \cup \{c_{kij}^t(o_{kij})\}$$

For the options which exist at time t , that is p^t , agent i give the position value p_i^t which based on option value Vo_{ki}^t and option perception value Vpo_{kij}^t that had been got.

Definition 6:

$Vp_i^t : p_i^t \rightarrow \mathfrak{R}$ is position value which had given by agent i at time t that is

$$Vp_i^t(p_i^t) = Vo_{ki}^t + \sum_m Vpo_{kij}^t \quad m = \text{number option and } (i \neq j).$$

For the position that had exist at time t that is p^t , agent i give value of position perception p_j^t ($i \neq j$) which based on option perception value that had been derived Vpo_{kij}^t .

Definition 7:

$Vpp_i^t : p_j^t \rightarrow \mathfrak{R}$ is value of position perception which had given by agent i to position agent j at time t that is

$$Vpp_i^t(p_j^t) = Vo_{ki}^t + \sum_m Vpo_{kij}^t \quad m = \text{number option and } (i \neq j).$$

If agent j is not choosing option k then perception value option k was based on perception value agent i which had been choose by agent i .

For the position that had been exist at time t , that is p^t , will become a threat at time t , that is

$$t^t = \{t_1^t, t_2^t, t_3^t, \dots, t_n^t\} \quad n = \text{number of agent}$$

Agent Based Simulation of Negotiation Process Using Drama Theory

Definition 8:

For each agent i give a threat t_i^t which based on:

For each option o_{ik} which had been owned by agent i , agent i see the option for each agent j to option o_{ik} that is $c_j^t(o_{ik})$ so:

1. If option agent i to option o_{ik} is accept and if number of accept to option o_{ik} by agent j greater than or equal to number of reject to option o_{ik} which had been done for each agent j , then $t_i^t(o_{ik}) = \text{reject}$.
2. If option agent i to option o_{ik} is reject and if number of reject to option o_{ik} which had been done by every agent j is greater than or equal to number of accept to option o_{ik} which had been done for each agent j , then $t_i^t(o_{ik}) = \text{accept}$.

For threat t^t , each agent i give the value of threat perception Vpt_i^t that is:

$$Vpt_i^t : t^t \rightarrow \Re$$

Definition 9:

Value of threat perception Vpt_i^t which had been done by agent i based on option value Vo_{ki}^t and value of option perception Vpo_{kij}^t which had been owned, that is:

$$Vpt_i^t(t^t) = Vo_{ki}^t + \sum_m Vpo_{kij}^t$$

For each position agent i p_i^t , will forming a dilemma at time t which deal with position of agent j p_j^t and t^t that is d_{ij}^t .

Definition 10:

For each agent i will determine dilemma to agent j which based on value of position perception and value of threat perception, so:

1. If the value of option perception agent- j $Vpp_j^t(p_j^t)$ is greater than or equal to value of threat perception $Vpt_i^t(t^t)$ and value of option perception agent i $Vpp_i^t(p_i^t)$ is greater than or equal to value of threat perception $Vpt_j^t(t^t)$ then agent i was more like position agent j and agent j was like position agent i too, so the dilemma for this condition is rejection dilemma for agent- i and agent j .
2. If the value of option perception agent j $Vpp_j^t(p_j^t)$ is less than or equal to value of threat perception $Vpt_i^t(t^t)$ and value of option perception agent- i $Vpp_i^t(p_i^t)$ is less than or equal to value of threat perception $Vpt_j^t(t^t)$ then agent i was more like threat position and agent j was like threat position too, so dilemma for this condition is persuasion dilemma for agent i and agent j .
3. If value of option perception agent j $Vpp_j^t(p_j^t)$ is greater than or equal to value of threat perception $Vpt_i^t(t^t)$ and value of option perception agent i $Vpp_i^t(p_i^t)$ is less than or equal to value of threat perception $Vpt_j^t(t^t)$ then agent i is more like position agent j but agent j is more like threat position, so dilemma for this condition is rejection dilemma and persuasion dilemma for agent- i .

5. Model Negotiation

To reduce dilemma which appeared from drama framework, we make model with involving negotiation process among the agents who has a dilemma. In negotiation process, the action to accept offering from another agent is not only depend on offering value which had proposed. The addition of emotion into negotiation process will influence behavior of agent to take the action. The effect of emotion is rational, it means that there will be fact why someone is happy or sad.

Agent Based Simulation of Negotiation Process Using Drama Theory

In this model, negotiation process involve strategy and emotional state from each agent. Strategy will determine how much the ability for agent in order to do bargaining to another agent. The emotional state will determine how much behavior effect (how to speak, expression and emotional state) for agent in order to negotiate.

Every agent who has a dilemma to another agent will negotiate based on the strategy negotiation which had been used and his emotional state. The objective of this negotiation process is to bring another agent to change his mind to one or some option, where the option is conflict. An agent will change his mind to option depend on how much the effect of strategy and emotion of agent who will bargain to emotional state another agent which will influence perception value to certain option.

Negotiation will proceed at each time $t = \{1, 2, 3, \dots\}$. This model could get the condition where the agent who involves is not finding the solution for one or some option, so the problem was still having a dilemma.

Emotion model that will be used in this paper is the development from emotional negotiation model PAD. Emotional state model (PAD) involving three dimensional approach, i.e., Pleasure (P), Arousal (A) and Dominance (D). The first dimension Pleasure (P) gives the direction of emotions, positive emotion status (Pleasure) / negative emotion status (Displeasure). Generally, for humans, a positive emotional state is more conducive to a person acting in a friendly and sociable manner with others; conversely, a negative emotional state tends to heighten chances that the individual will be unfriendly, inconsiderate, or even rude to others.

During negotiation, a more pleasant agent tends to cooperate with others or tends to accept others' offers; on the contrary, a more unpleasant agent tends to reject others' offers. We can reflect this relationship to the value system by assuming that pleasure makes the agent increase the evaluation value and displeasure makes the agent decrease the value. The second dimension A: Arousal–Non-arousal. This gives the degree of effects on the above intentions as given by P. Arousal means to rouse or stimulate to action or to physiological readiness for activity. We can reflect this to the value system of negotiation by assuming that this measure magnifies or minimizes P's affection. For example, if an agent is in pleasure status this emotion makes the agent increase the evaluation value a little; if the agent is also on arousal, it increases even more. But, if the agent is in displeasure, then arousal will make the agent decrease the value more. The third dimension D: Dominance–Submissiveness. This estimates the degree of the ability of being commanding, controlling, or prevailing over all others, or degree to yield oneself to the authority or will of another.

Definition 11:

For each agent has the emotional state, i.e.:

$$Es_i = \{r_p, r_a, r_d\} \quad r_p, r_a, r_d \in (-1, 1)$$

The values have negative meaning if close to -1 and have positive meaning if close to 1.

Definition 12:

For each agent i have the function of emotional state, that is:

$$Se_i(r_p, r_a, r_d) = r_p \cdot (1 + r_a) - r_d$$

Definition 13:

The strategy (bargaining strategy) space for agent is the set of positive integer number $st = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$.

Protocol Negotiation

For each time of negotiation $t = \{1, 2, 3, \dots\}$, agent i and agent j will negotiate if there are dilemma among them. From the present position p_i^{t-1} and p_j^{t-1} , they will negotiate in option which had been difference in their option (agent i reject and agent j accept or vice versa). Agent i with bargaining strategy $st_i = s$ and emotional state $Es_i = \{r_p, r_a, r_d\}$ will offering with value:

$$Ov_i = Se_i \times st_i + st_i$$

This equation shows how much the effect of negotiation which had been done by agent i with involving strategy and emotional state. The value of bargaining strategy $st_i = s$ will reduce a perception value of agent i 's choice to perception value which had been choose. Also, it will add a

Agent Based Simulation of Negotiation Process Using Drama Theory

perception value of agent i's choice to perception value which had not been choose at the option was not deal (option agent i and agent j is not suitable).

Agent j have an emotional state $Es_j = \{r_p, r_a, r_d\}$ which influence agent j in order to accept the offer from agent i. With emotional state of agent j $Se_j(r_p, r_a, r_d) = r_p \cdot (1 + r_a) - r_d$, agent j will assessing the offer of agent i with level of offering which was felt by agent j, that is

$$Ov_j = Se_j \times Ov_i + Ov_i$$

The effect of negotiation value will reduce the option of perception value agent j to his perception value which had been chose and will add a perception value of agent j to his perception value which had not been choose at the option was not deal (option agent i and agent j is not suitable).

This negotiation process will occur for agent j who will negotiate with agent I or vice versa. If agent i negotiate with agent j, then agent i will act as bargainer party who has a strategy and agent j act as an offer receiver.

This negotiation process will run until time t, which is for each time t, each agent will update his preference value and make the choice again based on his present preference value. In this paper, the analysis is to measure level of emotional state, so the agent could negotiate in order to reduce dilemma.

6. Simulation

We will simulate a problem in Citarum river basin in section 3. Based on common frame in figure 4, we make the observation to the parties who involve for getting a perception value in a view to present common frame. The following is perception value from each agent which shows perception value to the option, if this option was chosen by another agent. This value was obtained from data based on common reference frame in figure 4.

Table 1. Perception Value of each agent in Citarum River Basin Problem

OPTIONS OF PARTICIPANTS	USR		G		TI		DSP		USP		DSC	
	A	R	A	R	A	R	A	R	A	R	A	R
USR												
Stop deforestation	51	.49	60	40	0	0	55	45	25	75	51	49
G												
Protest	47	53	43	57	49	51	0	0	13	87	49	51
TI												
Stop un-treatment waste disposal	0	0	57	43	45	55	55	45	0	0	51	49
DSP												
Stop waste disposal to river	0	0	51	49	0	0	49	51	0	0	51	49
USP												
Stop illegal lodging	60	40	51	49	0	0	51	49	37	63	51	49
DSC												
Strict penalties for illegal waste disposal	0	0	75	25	48	52	41	59	0	0	49	51
Maintenance down Stream River	0	0	51	49	0	0	52	48	0	0	46	54
Revenue sharing to Up Stream Regencies	56	44	0	0	0	0	0	0	0	0	43	57

Agent Based Simulation of Negotiation Process Using Drama Theory

Based on the above table for Citarum river basin problem could be explained as following:

1. Up Stream Regencies (USR)
 - a. At this time, USR accept to stop deforestation because it will give a big opportunity. Indirectly, it will give opportunities for all parties, because with stopping deforestation, there are no floods anymore. USR will give a value more high than value for option “*accept stop deforestation*”, even though the value was not far different.
 - b. USR didn’t want Green to make protest for stopping deforestation for this time. If there are some policies to answer this problem, then Green can make protest to stop deforestation. USR give value not big, because it can be compromised.
 - c. USR have opinion that USP must stop illegal lodging that will cause flood according to option that had been offered by USR. USR will give a high value for option “*accept stop illegal lodging*”.
 - d. At this time, USR want DSC to sharing revenue by giving earnings to up stream regencies for maintaining a forest and there is no compromise. USR will give a more high value for option “*accept revenue sharing*”, even though the value was not far different.
 - e. USR didn’t give a value for option TI, which is stop un-treatment waste disposal to river, not give value for option DSP, that is to stop waste disposal to river and not give value for option DSC. It happens because USR feels that those options have no opportunities.
2. Green (G)
 - a. Position Green at this moment is not making protest, but this position could be change to action protest. Green will give value for reject rather bigger than accept position, but the value difference was not far.
 - b. Green have the opinion that USR must accept to stop deforestation and there is no compromise, textile industries must stop waste disposal to river, because it dangerous. USP must stop illegal lodging, it will cause floods. Down stream cities must give strict penalties for illegal waste disposal to river and maintain a river with clearing from garbage and dredging routine. Green will give values to accept for this whole option is higher.
 - c. Green didn’t give a value for option DSC, which is to sharing revenue. It happens because green feels that those options have no opportunities.
3. Textile Industries (TI)
 - a. For this time, textiles industries reject to stop waste disposal to river, because need much money, so the company couldn’t get profit. A textile industry prefers to like reject the option, so the value for reject this option is higher.
 - b. Textile industries didn’t give a value for option USR, which is stop deforestation, not give value for option DSP, that is to stop waste disposal to river and not give value for option DSC to maintain the river and sharing revenues. It happened because TI feels that those options have no opportunities.
 - c. Textile industries reject the protest action from Green about un-treatment waste disposal to river. Textile industries will give more high values for option to reject protest from Green.
 - d. Textile industries reject the action of down stream cities to give strict penalties for illegal waste disposal to river with give higher rejection values. It will cause a bankrupt for textile industries.
4. Down Stream People (DSP)
 - a. DSP still not want to stop waste disposal to river because there is no local policies from government, there is no availability of facilities to waste disposal. So there is no choice to waste disposal to river. This option could be changed if the infrastructure was ready. DSP give values for rejecting this option is not too higher.
 - b. DSP didn’t give a value for option Green, which is to make protest and not give value for option DSC to share the revenue. It happens because Green feels that those options have no opportunities.
 - c. DSP have opinion that USR must stop deforestation, textile industries must stop waste disposal to river, because it dangerous. USP must stop illegal lodging, it will cause floods. DSP give values to accept this option is higher.
 - d. DSP reject DSC to give strict penalties for illegal waste disposal to river, because for this moment people still waste disposal to river. If local government was giving some facilities to waste disposal, then the government can give strict penalties for illegal waste disposal. DSP will give the option to reject more a little high than accept.
 - e. DSP want DSC to maintain river with clearing garbage and it must been work in order not to

Agent Based Simulation of Negotiation Process Using Drama Theory

make a floods. DSP give values to accept this option is higher.

5. Up Stream People (USP)
 - a. At this time, USP reject to stop illegal lodging, because up stream regencies not offering the interest option yet, for example with opening employment. But if there is another option which can give some profit, then illegal lodging will be stop. Indirectly, it can result a flood. USP will give the option to reject more a little high than accept.
 - b. USP didn't give a value for option TI, which is stop un-treatment waste disposal to river, not give value for option DSP, that is to stop waste disposal to river and not give value for option DSC to give strict penalties for illegal waste disposal and to maintain a river. It happens because USR feels that those options have no opportunities.
 - c. USP reject USR to stop deforestation, because it could be harming USP that is they don't have any work to do to fulfill their live. But, if USR give an interesting option to USP, then USP maybe will stop the illegal lodging, because the fact, it's very dangerous. USP will give the option to reject more high than to accept.
 - d. For this time, USP reject the protest action from Green about illegal lodging. Because this activities was still useful to fulfill their live. USP give values to reject this option are higher.
6. Down Stream Cities (DSC)
 - a. For this time, DSC reject to give strict penalties for illegal waste disposal, because they conscious that they couldn't provide a facilities to waste disposal. But maybe, for the next future DSC can provide some facilities, so can give strict penalties. DSC will give the option to reject more high than to accept.
 - b. DSC is not yet doing maintenance by free away from waste, because the habit of people is still waste disposal and there are no facilities to support this program. But if the infrastructure was ready, maybe DSC will maintain the river to keep clean. DSC will give the option to reject more high than to accept.
 - c. DSC reject to share the revenue to upstream regencies to maintain river for this time, but if the river become clean later then it make the down stream cities get the opportunity. DSC will give the option to reject more high than to accept.
 - d. DSC accepts USR to stop deforestation, because it will add a burden for DSC if there are floods. Textile industries must stop un-treatment waste disposal to river and USP must stop illegal lodging because it will add a burden for DSC. USP give values to accept this option is higher than to reject.
 - e. DSC at this time wants Green not to make protest. It was accommodated with situation for this moment. There still no good facilities and policies from local government. USP give value to reject this option is higher.

In order to simulate this problem, we use SOARS to look the initial frame for Citarum river basin problem. We describe an initial frame in figure 5. There are so many dilemmas in our common frame.

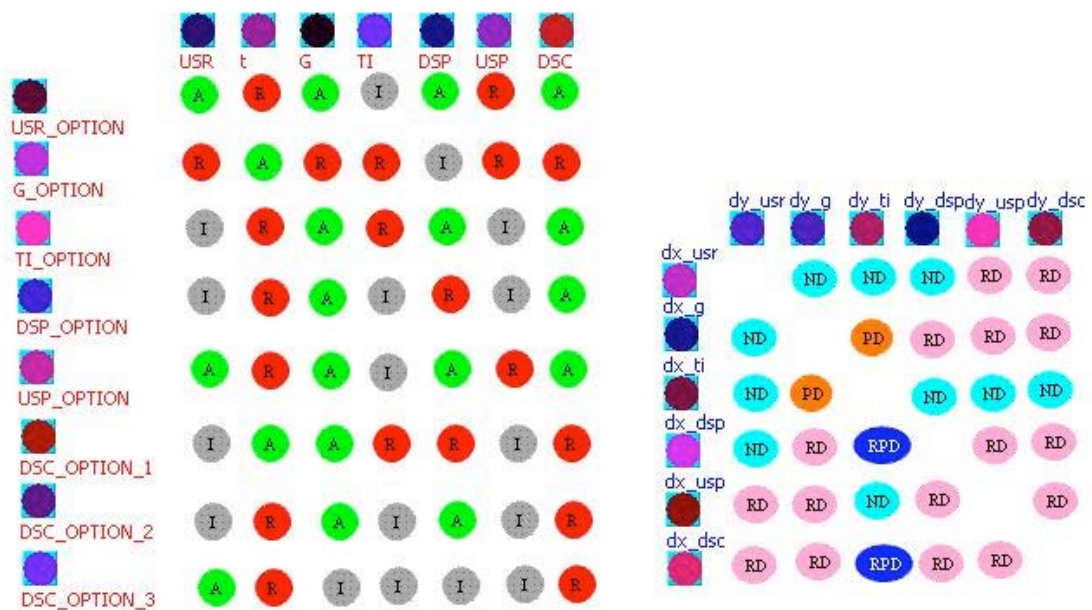


Figure 5. Initial Common Frame in Citarum River Basin Problem by using SOARS

Agent Based Simulation of Negotiation Process Using Drama Theory

In this simulation, we assume that bargaining strategy of agent was same, that is $st_i = s \in \mathbf{S}_t$. The purpose is to look the effect of emotional state from each agent. We assume that if the number of emotion function value is positive, then agent will have a behavior that like to compromise and will not compromise if the emotion function value is negative.

In this simulation, we make four experiments (4 scenarios) to look measure level of emotional state, so the agent could negotiate in order to reduce dilemma. Parameter in this scenario is emotional state, i.e. $Es_i = \{r_p, r_a, r_d\}$, where $r_p, r_a, r_d \in (-1, 1)$. The values have negative meaning if close to -1 and have positive meaning if close to 1. For each agent i have the function of emotional state, that is $Se_i(r_p, r_a, r_d) = r_p \cdot (1 + r_a) - r_d$

a. Scenario 1

In this scenario, USR have a positive emotional, so USR tends to accept other's offer. Green has a negative emotional, so Green tends not to compromise with the other, TI have a positive emotional, so TI tends to make compromise with other to stop un-treatment waste disposal. DSP have a negative emotional, so DSP tend not to make compromise with other agent (to stop waste disposal to river). USP have a positive emotional, so USP tends to accept other's offer or tends to cooperate with other agent to stop illegal lodging. DSC have a small value of positive emotional, so DSC tends to accept other's offer or tends to cooperate with other agent to make strict penalties for illegal waste disposal, maintenance and sharing revenue.

We use the following parameters in this scenario, i.e.:

	USR	G	TI	DSP	USP	DSC
r_p	1	0.5	1	0.2	1	0.8
r_a	0.5	0.6	0.7	0.6	0.5	0.5
r_d	0	1	0.5	1	0	0.9
$Se_i(r_p, r_a, r_d) = r_p \cdot (1 + r_a) - r_d$	1.5	-0.2	1.2	-0.68	1.5	0.3

In scenario 1, if there are agents who have positive emotional and another agent still has negative emotional, then the result of simulation is following.

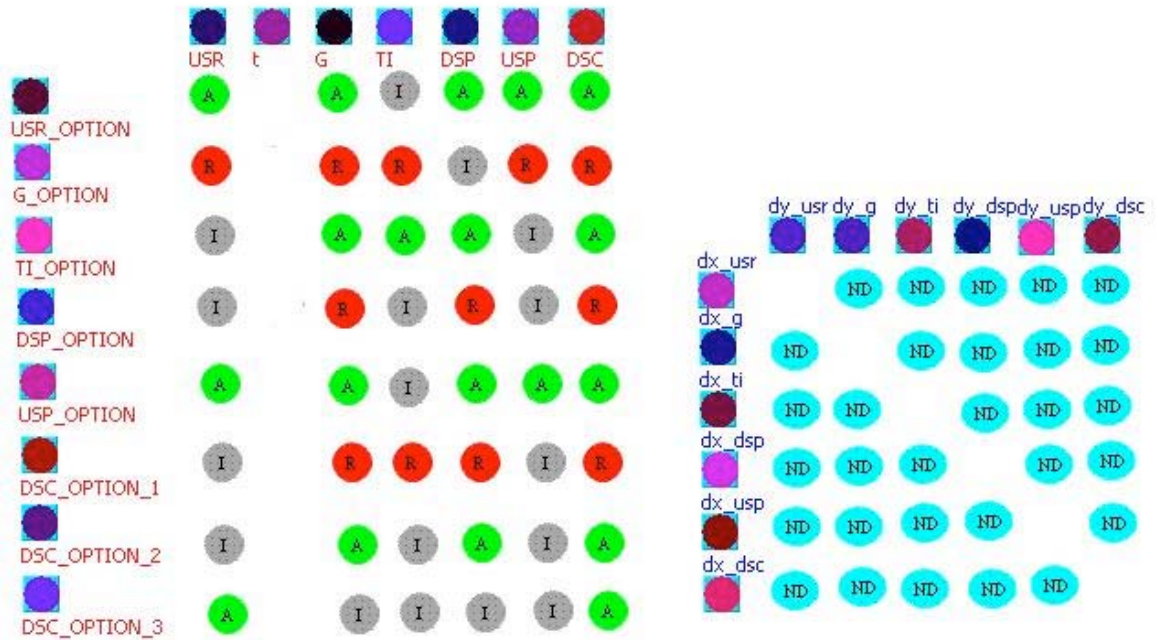


Figure 6. New Common Frame in Scenario 1 by using SOARS

From the above figure, could be seen that there are no dilemmas in this new common frame. It was caused by effect of positive emotional state from agents like USR, TI, USP and DSC. The number

Agent Based Simulation of Negotiation Process Using Drama Theory

of dilemma in this scenario was reduced as could be seen in following figure. The time of reducing a dilemma was slow moving, but finally dilemma can be reduced.

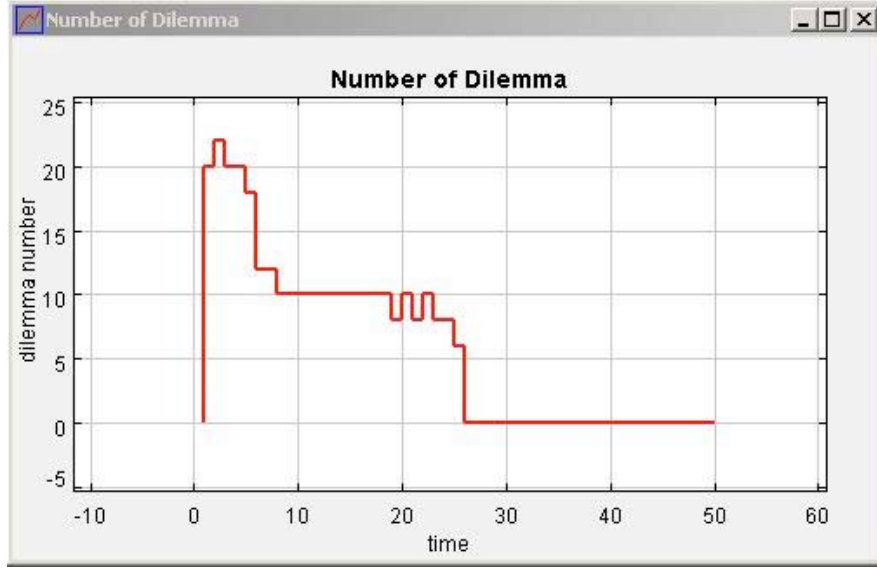


Figure 7. Graphic of Number Dilemma in Scenario 1

b. Scenario 2

In this scenario, USR have a positive emotional, so USR tends to accept other's offer. Green has a positive emotional, so Green tends to compromise with the other, TI have a positive emotional, so TI tends to make compromise with other to stop un-treatment waste disposal. DSP have a negative emotional, so DSP tend to make compromise with other agent (to stop waste disposal to river). USP have a positive emotional, so USP tends to accept other's offer or tends to cooperate with other agent to stop illegal lodging. DSC have positive emotional, so DSC tends to accept other's offer or tends to cooperate with other agent to make strict penalties for illegal waste disposal, maintenance and sharing revenue.

We use the following parameters in this scenario, i.e.:

	USR	G	TI	DSP	USP	DSC
r_p	1	0.5	1	0.2	1	0.8
r_a	0.1	0.6	0.1	0.6	0.5	0.5
r_d	-0.5	0	0.8	0	0.7	0.1
$Se_i(r_p, r_a, r_d) = r_p \cdot (1 + r_a) - r_d$	1.6	0.8	0.3	0.32	0.8	1.1

In scenario 2, the whole of agents have positive emotional, then the result of simulation is following.

Agent Based Simulation of Negotiation Process Using Drama Theory

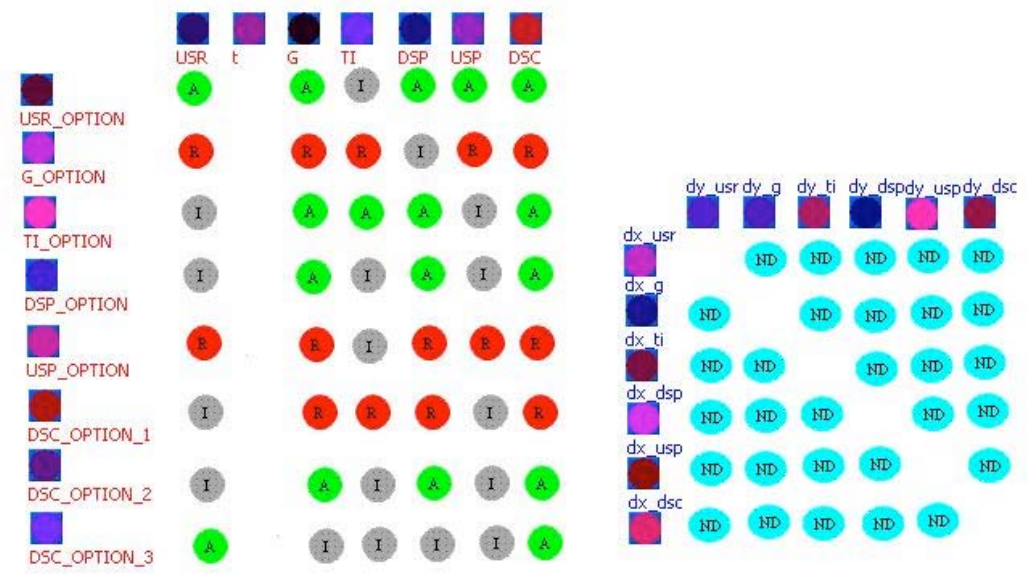


Figure 8. New Common Frame in Scenario 2 by using SOARS

From the above figure, could be seen that there are no dilemmas in this new common frame. It was caused by effect of positive emotional state from whole agents like USR, G, TI, USP, DSP and DSC. The number of dilemma in this scenario was reduced as could be seen in following figure. The time of reducing a dilemma was fast moving rather than scenario 1. It cause of the effect of positive emotional from whole agents.

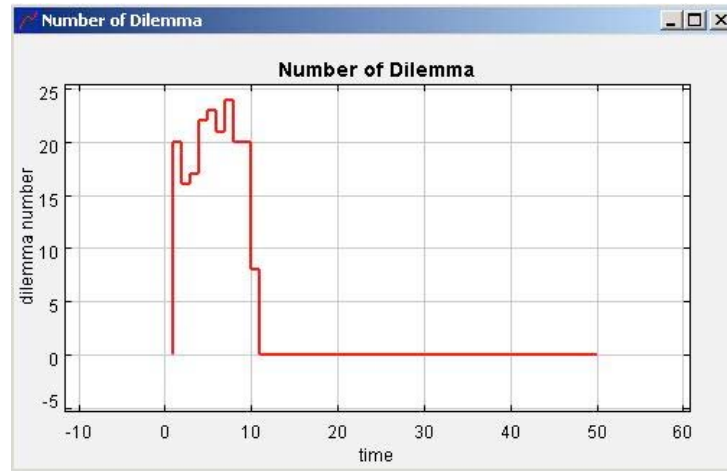


Figure 9. Graphic of Number Dilemma in Scenario 2

c. Scenario 3

In this scenario, USR have a positive emotional, so USR tends to accept other's offer. Green has a positive emotional, so Green tends to compromise with the other, TI have a positive emotional, so TI tends to make compromise with other to stop un-treatment waste disposal. DSP have a positive emotional, so DSP tend to make compromise with other agent (to stop waste disposal to river). USP have a positive emotional, so USP tends to accept other's offer or tends to cooperate with other agent to stop illegal lodging. DSC have positive emotional, so DSC tends to accept other's offer or tends to cooperate with other agent to make strict penalties for illegal waste disposal, maintenance and sharing revenue.

We use the following parameters in this scenario, i.e.:

	USR	G	TI	DSP	USP	DSC
r_p	1	1	1	1	1	1
r_a	0.1	0.1	0.1	0.1	0.1	0.1
r_d	1	1	1	1	1	1
$Se_i(r_p, r_a, r_d) = r_p \cdot (1 + r_a) - r_d$	0.1	0.1	0.1	0.1	0.1	0.1

Agent Based Simulation of Negotiation Process Using Drama Theory

In scenario 2, the whole of agents have a same value for positive emotional and have a low value, that is 0.1, then the result of simulation is following.

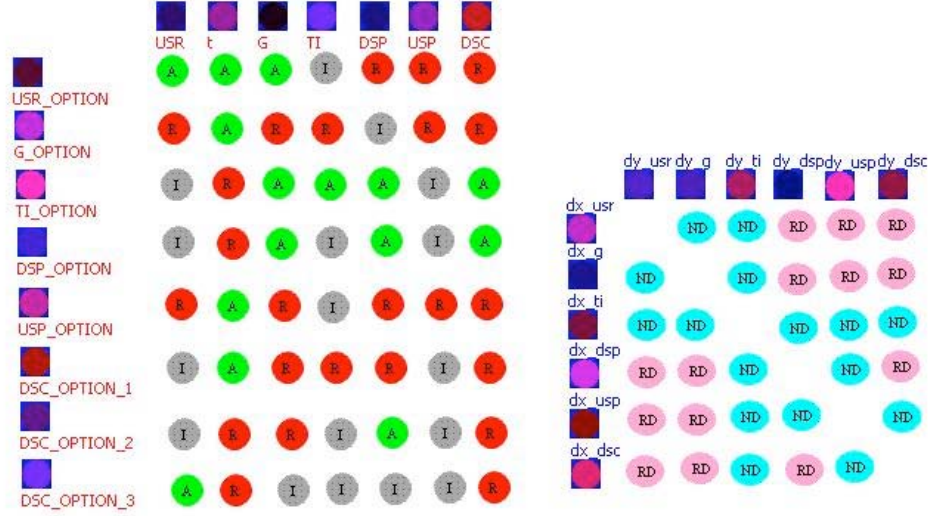


Figure 10. New Common Frame in Scenario 3 by using SOARS

From the above figure, could be seen that there are some dilemmas in this new common frame. It was caused by effect for low value of positive emotional state from whole agents like USR, G, TI, USP, DSP and DSC. The number of dilemma in this scenario couldn't reduced as could be seen in following figure.

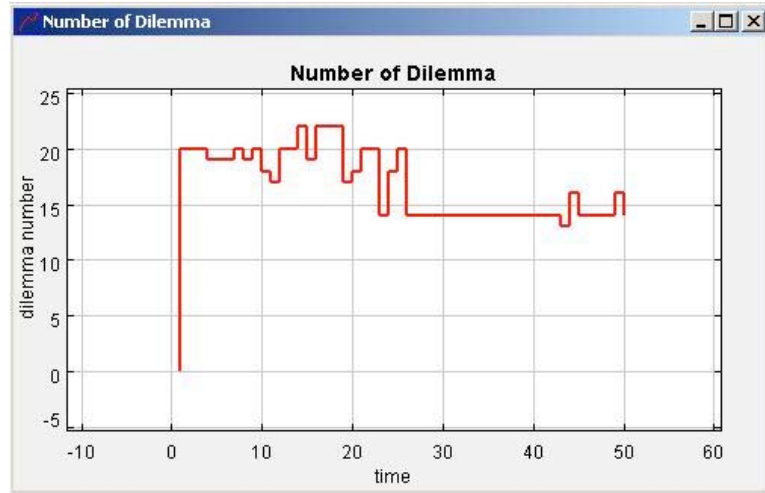


Figure 11. Graphic of Number Dilemma in Scenario 3

d. Scenario 4

In this scenario, USR have a negative emotional, so USR tends to reject other's offer. Green has a negative emotional, so Green tends not to compromise with the other, TI have a negative emotional, so TI tends not to make compromise with other to stop un-treatment waste disposal. DSP have a negative emotional, so DSP tend not to make compromise with other agent (to stop waste disposal to river). USP have a negative emotional, so USP tends not to accept other's offer or tends to cooperate with other agent to stop illegal lodging. DSC have negative emotional, so DSC tends not to accept other's offer or tends to cooperate with other agent to make strict penalties for illegal waste disposal, maintenance and sharing revenue.

We use the following parameters in this scenario, i.e.:

	USR	G	TI	DSP	USP	DSC
r_p	1	1	1	1	1	1
r_a	-0.8	-0.4	-0.1	-0.5	-0.4	-0.2
r_d	1	1	1	1	1	1
$Se_i(r_p, r_a, r_d) = r_p \cdot (1 + r_a) - r_d$	-0.8	-0.4	-0.9	-0.5	-0.4	-0.2

Agent Based Simulation of Negotiation Process Using Drama Theory

In scenario 2, the whole of agents have a negative emotional, and then the result of simulation is following.

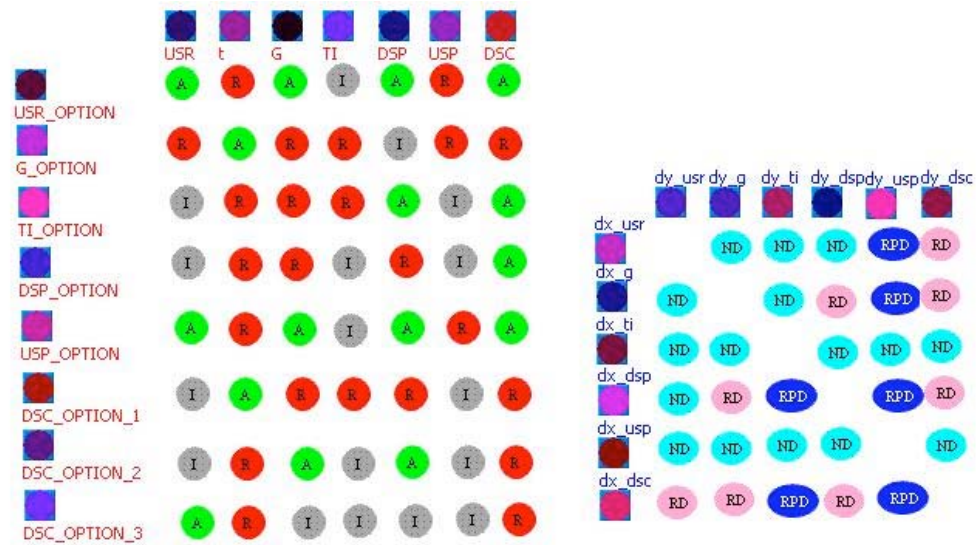


Figure 12. New Common Frame in Scenario 4 by using SOARS

From the above figure, could be seen that there are some dilemmas in this new common frame. It was caused by effect of negative emotional state from whole agents like USR, G, TI, USP, DSP and DSC. Each agent tends not to make compromise with their option, so the number of dilemma in this scenario couldn't reduce as could be seen in following figure.

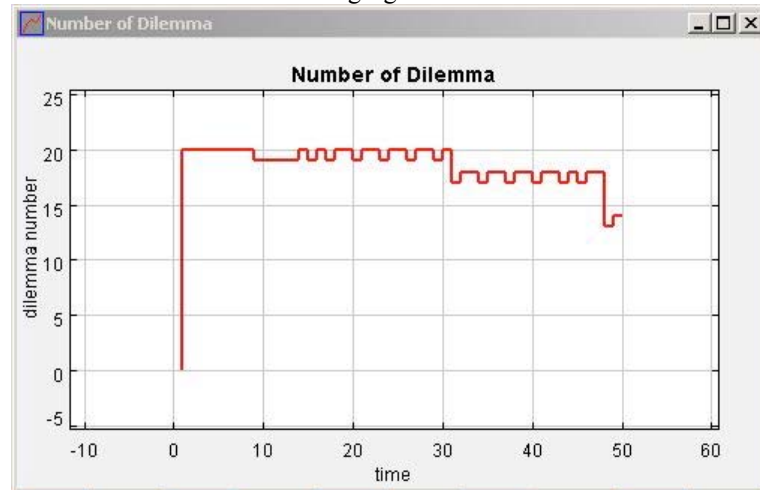


Figure 13. Graphic of Number Dilemma in Scenario 4

7. Conclusion

In the work above, we show how the emotional states of agents affect their negotiations strategy, which is an important. In our simulation, the effect of positive emotional state of agent is important to make negotiation and the result from simulation show that the number of dilemma between agents who involve in Citarum River basin problem could be reduced.

Positive emotion means that the agent tends to make compromise or tends to accept other's offer. This emotion must be own by each agent in Citarum River basin problem, so the dilemma can be reduced.

From the result of simulation, if whole agent has a negative emotion, then the dilemma still existed. There is no compromise, so dilemma still appears in this problem. So the suggestion for this problem is each agent must have a positive emotion which consists of three dimensional, that is pleasure, arousal and dominance in order to negotiate.

Agent Based Simulation of Negotiation Process Using Drama Theory

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