Conflict Resolution Using Graph Model for Conflict Resolution

Case Study on Majalaya's Textile Industries Waste Pollution

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Abstract— **This study is aimed at analyzing conflict resolution using a Graph Model for Conflict Resolution (GMCR) approach. The research object is waste pollution case in Majalaya's textile industry in the upstream area of Citarum river in Bandung regency. GMCR is used to describe the agreed optimal solution based on the preferences of each party involved in the conflict, namely the government of West Java province, the residents of Majalaya, the textile industry, and the independent environmental expert in the city of Bandung. From the results of stability analysis, it is discovered that there are only two stable scenarios (equilibrium) for all parties, namely scenario 6 (happy ending) and 9 (bad ending). Scenario 9 is called a bad ending scenario, because the local residents ultimately held a demonstration against the textile industry since the government did not give them a strict punishment for causing waste pollution as they have not maximized their WWTP functions, thus it would cause an operational disruption of the textile industry. While scenario 6 is called happy ending scenario because the textile industry eventually maximized their WWTP functions, the local people would not go on demonstration, and the environmental experts would not make negative publicity about the textile industry. In conclusion, based on sensitivity analysis, scenario 6 was more expected to occur by a textile industry as the conflict resolution over the Majalaya's waste pollution case. However, to achieve scenario 6, some compensations should be given by other parties to the local residents of Majalaya and to the independent environmental experts. If the compensations were not given then it is very likely that scenario 9 would happen and it would become the resolution of conflict for the textile industry waste pollution case in Majalaya.**

Keywords—Conflict Resolution, GMCR, Majalaya Textile Industry

I. INTRODUCTION

Citarum is the longest river in West Java. The river runs along 297 kilometers of Mount Wayang in the southern part of Bandung to the north and ends in Java Sea in Muara Gembong, Bekasi Regency. The river is the source of water for nine regencies and three cities in West Java, including Bandung Regency, Karawang, Purwakarta, Cianjur, Bandung, Cimahi and Bekasi. The watershed of Citarum reaches 6.614 square kilometers wide. Around 25 million people in nine regencies and three cities rely on this river.

Ironically, the current condition of Citarum river is very poor. Citarum River is known as the most polluted river in the world. Frequent flooding seems to be the things that are familiar to people around the Citarum river banks. There are about 500 factories located in the upstream area of Citarum, the majority of which are textile factories. Of the all factories, only 20 percent process their waste using Waste Water Treatment Plant (WWTP), the rests dump their waste into the sub-watersheds that run to Citarum. Indonesian Forum for Environment (WALHI) has ever accompanied three cases of serious pollution in Rancaekek, Majalaya and Saguling. But none of the cases went to court. This shows that law enforcement on the parties undertaking pollution to Citarum is very weak.

Waste disposal by the industries is not always discharged directly to Citarum river, but also through its tributaries. The Greenpeace reports mention that in several tributaries that end to Citarum river, including Citarik River, Cikijing river, Cicalengka River, Cimande river and Cisunggalah River, the concentrations of heavy metals in sufficient quantities are surprisingly found in the river water body. Those five creeks are located in the area of Rancaekek-Cicalengka, where 42 textile mills are in operation.

Not only focusing on the advocacy of waste pollution problem, but Greenpeace also advocates that waste management should be started from the upstream. Having launched a joint action (with the government) by marking signs in the factories that dump waste directly to Citarum river in November 2012, Greenpeace also advocates the entrepreneurs of large textile industries to use natural materials in their productions, aiming at reducing pollutants.

In industrial area such as Jababeka, Cikarang sub-district, Bekasi Regency, sewage treatment in an industrial area covering 1,570 hectares and containing more than 1,400 local and multinational companies from 29 countries has been made integrated. This method is effective for the environmental management of industrial estates. But again, in the context of Majalaya's case, where the industries are so spread out, starting from those of small-scales belonging to the society to large enterprises, the integrated waste management in one location becomes almost impossible.

Another emerging discourse is the relocation of industrial areas out of Majalaya, which indeed is the Citarum's upstream region. It technically seems to be the most plausible alternative. However what would be very complicated are the social costs and problems, therefore this discourse needs further study in-depth.

To strongly warn, or to send, the "naughty" industries which dump their waste directly into the river without being processed to the court, to taking action campaign to seal their plants have not seemed to be an effective way to solve the severity of waste problems in Majalaya.

Industry and its contribution to the economy in a region is something that cannot be underestimated. To revoke licenses and shut down industrial companies are not wise instant solutions. On the other hand, if the handling of waste is not immediately done, then in the long term, the predicted losses and environmental disaster will haunt our lives, especially for people who live along the stream of Citarum river and its beneficiaries.

In this study, GMCR is used to describe the optimal solution that will be obtained in this conflict based on the preferences of each party involved. The combination of preferences from each side will create some scenarios that can be used to analyze its stability. The purpose of stability analysis of those scenarios is to see which scenario that finally shows the equilibrium point for all parties involved in the conflict and is able to generate resolution for the conflict of Majalaya textile industries' waste pollution in the upstream of Citarum river.

II. LITERATURE REVIEW

A. Conflict Resolution

Conflict is a process that begins when one party has perception that the other party has negatively affected, or will affect negatively, on something that becomes the concern or interest of the first party. This definition covers a variety of conflicts that people experience in organization, misalignment of the purposes, the different interpretation of the facts, disagreement caused by expectations of behavior, and so on [1]. Meanwhile, conflict management according to [2] is a constructive action planned, organized, driven and evaluated on a regular basis for all efforts to end the conflict. This study leads to the resolution of conflicts which in [3] is stated that the resolution of the conflict is a set of theoretical and experimental investigations in understanding the nature of conflict, examining the strategies for conflict, then making a resolution to the conflict.

B. Graph Model for Conflict Resolution

Game theory can be used to describe the process of conflict resolution. Game Theory was first introduced in 1944 by a mathematician John von Neuman and an economist Oskar Morgenstern in the book called Theory of Games and Economic Behavior [4].

Game theory is based on five assumptions as follows [5]:

1. The structure of a game is formed by choice or option available for the players and rewards they receive from choosing particular option.
2. The options available to the limited number of players and the players know what they are.
3. Results (payoffs) are associated with certain movements and they do not only depend on the choice of a player, but also depend on the choice of opponents.
4. The players know the results related to any combination of choices and interesting results, and have meaning for them.
5. The choice of a player is determined by calculating the results (rewards and costs). Rational behavior of the game consists of a selection of the choices that produce fun output, either a good maximum acquisition or an achievement of useful norms such as distributional justice.

Developing the science of game theory by proposing Graph Model for Conflict Resolution (GMCR) is a methodology for framing an interactive decision or conflict situations, in which the stability analysis can be generated [6]. It is job as an assessment tool of the best strategies in conflict resolution, which also serves as a means of stimulation for the interaction and behavior of decision makers. It can also be used in the preparation of mediation and negotiations.

C. Stability

And then [6] explains about stability. When a player does not have an incentive to move from a particular state, the state is called stable for the player, and the state is called equilibrium if it is stable for all the players.

$$G = (S, (A_i: i \in N)) \qquad (1)$$

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1)   Nash Stability

State k is the Nash Stable for player i if i cannot improve his payoff by changing his own strategies

$$S_i^+S_i^+(k) = \{\quad\} \qquad (2)$$

2)   Sequential Stability

And state *k* is Sequentially Stable for player *i* if for every $k_1 \in S_i^+ \in S_i^+(k)$, there exists $k_2 \in S_j^+ \in S_j^+(k_1)$ with $P_i(k) > P_i(k_2)$ (3)

D. State of The Art

Ref [7] and [8] are case study of Ichinose Community in Japan and about Conflict over Natural Resource Exploitation in a Mountainous Community. It has been applied across a wide range of application areas such as conflict Management on utilization of Gages Water Resources Between Bangladesh and India [9]. Also, conflict in environmental management [10]; [11]; [12]; [13]; [14]; [15]. In Indonesia, GMCR has been used in a variety of case study, example case of collaboration Coca-Cola and Carrefour by [16], and the case of real estate Conflict in [17].

III.   RESEARCH METHODOLOGY

This research is a qualitative study aimed at examining the conflicts arising from the conflict in the textile industry waste disposal in the upstream region of Citarum river by using GMCR.

Based on the time, this research goes into longitudinal research in which the data collection is not done in time, but in different time. This study took the time in 2010, 2011, 2013, and 2014 when the West Java provincial government led by H. Ahmad Heryawan (Governor of West Java) and Deddy Mizwar (Vice Governor of West Java). The research was limited around Majalaya textile industry areas located in the upstream part of Citarum River, Majalaya sub-district, Bandung regency.

By using a purposive sampling method and applying an in-depth interview, the data was obtained and its options are as follows. The power of the data source is the reference of the data validity. The consistency of the news contents at the source with other sources is an important stage to declare that the data can be trusted. At the end of the process, a sensitivity analysis is implemented if more than one choices of stable scenario are found.

In GMCR, there are some terms that have specific definitions, the following is a list of the terms:

1. *Players*
    In this GMCR there are 4 players, (1) West Java Provincial Government (2) The Textile Industry, (3) The residents / local people and (4) The Independent Environmental Expert.

2. *Option*
    Option is the freedom to choose from a number of alternative options. The options selected in this GMCR are based on interviews, observations and secondary data sources of mass media and internet media.

3. *Feasible State*
    Scenarios chosen from a number of possible scenarios. The number of resulted scenarios is formulated by 2^n, in which 2 is the possibility of "Yes" (Y) and "No" (N) and n is filled with a number of options available. After the scenario is drawn up, and then the researchers will only select the one that just might to happen based on the observations, secondary data sources, and interviews. Thus the total scenario obtained is 64 results of 2^6, but only 13 scenarios are considered feasible by the researcher.

4. *Preference*
    Preference is the tendency of the players. In writing, the more it is to the left, meaning that the higher the preference is for the player.

5. *Stability*
    It is the analysis to see the possibility of any scenarios which are equilibrium for all players.

6. *Return (Payoff)*
    Payoff is a number associated with all possible outcomes.

7. *Equilibrium (E)*
    It means that each player uses a very good strategy in responding to the strategies of other players. The position is marked E if it is proven to be stable for all players.

8. *Nash Stability (r)*
    Nash stability occurs if a player does not have an incentive to switch position, because the other positions which may not be better than the present position.

9. *Unstable (u)*
    Unstable (u) is a condition in which the player has an incentive to move to a position where the new position has a higher payoff than his current position.

After determining the parties involved as well as the options for what is being done by each party, the researchers can determine a framework of the feasible states that may occur. The following are the parties and their options shown in Table 1.

TABLE 1. LIST OF EACH PARTY (PLAYER) AND THE OPTIONS

Party (*Player*)	Option
Textile industry (TI)	Maximizing function of the Waste-water Treatment Plant (WWTP)
West Java Provincial Government (G)	Giving strict punishment to the textile industry which proven to dump waste into the upstream watersheds of Citarum river without processing
	Doing 3-Re (Revision, Relocation and Recreation)
Society (S)	Demonstrating anarchically
	Moving to a place safer from waste of textile industry
Independent Environmental Experts (IEE)	Doing negative publicity about the dangers of the waste of textile industry in medias (printed and electronic)

The next step of the modeling process is the sorting scenario that reflects the preferences of each party/ decision makers. Such scenarios are sorted based on the rankings of the most desirable scenario on the left to the least preferred scenario on the right. This preference is important information that is required as the input for the stability analysis using a variety of solution concepts. The stability of each scenario is indicated using letters (r) for the Nash stable scenario (s) for the sequential stable scenario and (u) for the unstable scenario. Stable Nash is a condition where the players do not switch positions for other positions that do not have higher payoff than the current position. Then, it is observed which scenario that eventually is equilibrium for all parties, indicated by the letter (E). Scenario marked E means that the scenario is proven to have stable Nash for all parties. With the results of stability analysis on GMCR, the most optimal combination of choices is obtained, showing the equilibrium positions of each party.

IV. DATA ANALYSIS AND DISCUSSION

Based on the obtained primary and secondary data sources, the existing condition of the Majalaya textile industry waste pollution conflict in the upstream watershed (DAS) of Citarum can be seen in Table 2 as follows:

TABLE 2. EXISTING CONDITION

Party (player)	Option	
Textile Industry	Maximizing function WWTP (1)	N
West Java provincial government	Give strict punishment (2)	N
	Doing the program of 3-Re (3)	N
Residents of Majalaya	Organizing anarchist demonstrations (4)	Y
	Move (5)	N
Independent Environmental Experts	Making negative publicities (6)	Y

In the conflict of textile industry waste pollution in the watershed upstream of Citarum River in Majalaya, each of the parties involved has different options. The total available options are 6. The options are then combined to generate the scenario. Some of the conditions impossible to occur are:

1. To maximize the function of the WWTP and prevent the society from making demonstration. This condition is not likely to happen because there is no reason for people to go on a demo.
2. To maximize the WWTP functions and the government to provide a strict punishment. This condition is not likely to happen because there is no reason for the government to provide strict punishment.
3. The Government gives strict punishment and the people demonstrate. This condition is not likely to happen because there is no reason for people to go on a demo.

Based on that scenarios, the total scenarios considered feasible are only 13. The combination of feasible scenarios can be seen in Table 3 as follows:

TABLE 3. FEASIBLE STATE

Option	Scenario												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Textile Industry													
1. Maximizing the function of the Wastewater Treatment Plant (WWTP)	N	N	N	N	N	Y	N	N	N	N	N	N	N
West Java provincial government													
2. Give strict punishment to the textile industry which proved to dump wastes into the upstream area of Citarum river without processing	N	Y	N	N	Y	N	N	N	N	Y	N	Y	Y
3. Doing 3Re (Revision, Relocation and Recreation)	N	Y	N	Y	N	N	N	Y	Y	Y	Y	Y	Y
Residents of Majalaya													
4. Doing Anarchist Demo	Y	N	Y	Y	N	N	Y	Y	Y	N	Y	N	N
5. Moving to a place safer from the waste of textile industry	N	Y	N	Y	N	N	Y	N	N	N	Y	N	Y
Independent Environmental Experts													
6. Conducting negative publicity about the dangers of textile industry waste in medias (printed and electronic)	Y	N	N	N	Y	N	Y	N	Y	N	Y	Y	Y

Preferences:

Textile Industry :

6 > 4 > 2 > 13 > 10 > 11 > 7 > 12 > 5 > 3 > 1 > 8 > 9.

West Java Provincial Government :

13 > 2 > 5 > 11 > 4 > 9 > 8 > 6 > 12 > 7 > 1 > 10 > 3.

Residents of Majalaya :

12 > 5 > 10 > 6 > 9 > 7 > 8 > 3 > 13 > 11 > 2 > 4 > 1

Independent Environmental Experts :

11 > 13 > 7 > 2 > 4 > 12 > 10 > 6 > 5 > 9 > 8 > 1 > 3.

The results of the stability analysis on the Majalaya's textile industry waste pollution conflict can be seen in Table 3.

In Table 3, it can be seen that there are two scenarios where the equilibrium acceptable to all parties so that the final scenario can possibly be used as conflict resolution. The equilibrium scenarios are scenarios 6 and 9. Scenario 6 in which the textile industry maximizes the function of Waste Water Treatment Plant (WWTP). The government does not give any sanctions and does not do the 3-Re program, the local people do not go on a demonstration and move. The independent environmental expert does not make any negative publicity about the dangers of textile industry waste in any mass media.

Scenario 9 is that the textile industry does not maximize the functions of Waste Water Treatment Plant (WWTP), the government does not impose the sanctions but conducts the 3-Re program. People go on a demonstration but do not move. The independent environmental experts conduct negative publicity about the dangers of textile industry waste in the media.

In the conflict of Majalaya's textile industry waste pollution, scenario 9 is called as a bad ending scenario from the side of the textile industry. Due to this condition, the residents of Majalaya go on a demonstration. The governments perform the 3Re program so that it will interfere the comfort of the textile industry. On the other hand, scenario 6 is referred to as a happy ending scenario from the side of the textile industry. This condition may be due to the people do not go on a demonstration and move. Additionally, s the environmental experts does not create

any negative publicity regarding the textile industry since the textile industry has maximized its WWTP. Therefore, this condition can create comfort for the textile industry in Majalaya.

TABLE 4. STABILITY ANALYSIS RESULT

Textile Industry													
	E												E
Stability	r	r	r	r	r	r	r	r	r	r	R	r	r
State Ranking	6	4	2	13	10	11	7	12	5	3	1	8	9
Uis													
West Java Provincial Government													
							E		E				
Stability	r	r	r	r	r	r	r	r	u	u	R	u	u
State Ranking	13	2	5	11	4	9	8	6	12	7	1	10	3
Uis									5	11		9	8
Residents of Majalaya													
				E	E								
Stability	r	r	r	r	r	r	r	r	s	u	R	s	s
State Ranking	12	5	10	6	9	7	8	3	13	11	2	4	1
Uis									12	9		8	7
Independent Environmental Experts													
									E		E		
Stability	r	r	r	s	s	r	r	r	s	r	U	r	s
State Ranking	11	13	7	2	4	12	10	6	5	9	8	1	3
Uis				13	11				10		9		1

V. CONCLUSION

There are two stable scenarios in the game e.g. scenario 6 and scenario 9. Scenario 9 is called a bad ending scenario, because ultimately the residents remain go on a demonstration against the textile industry. This is caused by the government that does not give strict punishment to the textile industry causing waste pollution. Since the industry does not maximize the function of its WWTP, the protesting demos would disrupt the operation of the textile industry. On the contrary, the scenario 6 is referred to as a happy ending scenario because at the end, the textile industry maximizes its function of its WWTP and the people do not go on a demonstration. Additionally, the environmental experts do not do negative publicity about the textile industry. Therefore, scenario 6 is expected to occur by Textile Industry as the resolution of conflict in the Majalaya textile industry waste pollution. However, to achieve scenario 6 there are some compensations should be given by other parties to the residents of Majalaya and the independent environmental experts. If the compensations are not given then the most likely scenario that occurs is 9 which will be the resolution of conflict in the textile industry waste pollution of Majalaya.

VI. RECOMMENDATION

In the condition of this conflict, Textile Industry should be able to address the conflict through environmental awareness by conducting CSR programs. The positive impact if the company performs CSR are:

1. Developing the reputation or image of the company in the eyes of consumers and investors
2. Eliminating environmental and social conflict around the company
3. Promoting cooperation with stakeholders
4. Differentiating the company with its competitors

One of the CSR program that can be done by Textile Industry is to establish a Public Health Center (Puskesmas).

In addition to being a means of treatment, the public health center can also be a means of socialization from Textile Industry to the public that they are textile industry that is environmentally friendly. .

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