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MULTI-OBJECTIVE OPTIMIZATION FOR CONFLICT RESOLUTION IN CONSTRUCTION PROJECTS

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In construction projects, the different interests and objects of stakeholders can result in increased occurrences of conflict, which can bring negative effects or even project termination. In particular, understanding the causes and finding a solution get more difficult because of the larger and more complex projects. Thus, quantitative research should be conducted to find conflict alternatives. This study aims to find optimal alternative combinations for conflict resolution in public projects. To understand level of conflict and effect of conflict alternatives, the survey was conducted in three points of view: 1) economic; 2) social; and 3) environmental. After survey, the optimization process consists of two steps. First, weights of conflict factors are estimated through regression analysis. Second, multi-object functions which are each economic impact, social impact, environmental impact are optimized. For multi-objective optimization, optimal alternative combinations could be deducted and results present how alternatives affect to conflict level. Although there are some limitations, this result is significant in that it has found an optimal alternative considering three impacts in order to select a combination of alternatives for conflict resolution.

Keywords: Development, Multi-objective optimization, Genetic algorithm.

1 INTRODUCTION

As the economy grows at the national level, people focus more on values such as social and environmental issues. This affect the improvement of human rights, the development of media and civil society. This has many positive aspects to achieve a mature civil society, but this impact increases the conflict between the various stakeholders in the construction project (Li *et al*. 2013). The different interests and objects of stakeholders can result in increased occurrences of conflict have an enormous effect on project performance like project delay or increase of cost, and even project termination (Jia *et al*. 2011). In addition, conflicts also have negative effects on regional emotions, social divisions, and polarization. In the past, construction projects have been made by the government-led Decision-Announcement-Defense (DAD) method but the construction industry should focus on developed social governance. Although the central and local government continue their efforts to resolve conflicts, for example, through the analysis of conflict effects in the project-planning phase, conflict occurrence continues to increase. Therefore, construction industry has to focus on not only performance but also sustainable development. In other words, for sustainable development, how to resolve the conflict is very important issues (Brockman 2013). To solve this conflict, there are many researches related to conflict. However previous researches have focused on only mechanism of conflict or structuring the causes of conflict. Although the researches that result in conflict resolution or finding alternatives, they used the qualitative methodology is used and argued the attitude or satisfaction of stakeholders(Kassab *et al*. 2006). Therefore, quantitative research should be conducted to find conflict alternatives. This study aims to find optimal alternative combinations for conflict resolution in public projects and to derive the sensitivity of alternatives to each impact.

2 RESEARCH FRAMEWORK

To deduct optimal solution for resolving conflict, both performance and sustainability are to be considered. Understanding how affect each alternative to performance and sustainability is key uncertainty. In this research, economic impact is regarded to performance and social impact, and environmental impact are regarded to sustainability. In other words, economic impact, social impact, environmental impacts are uncertain variables in this research. Each impact consists of an equation for conflict factors and alternatives which stem from literature reviews. Then a survey is proceeded to collect uncertain variable data and one conflict case is selected, Mi-ryang transmission project in Korea. The questionnaire was asked for the level of conflict on economic, social, and environmental issues and how conflicts are resolved in applying alternatives. The research process consists of two steps as Figure 1. First, weights of conflict factors are calculated through regression analysis. Second, multi-object functions are optimized.

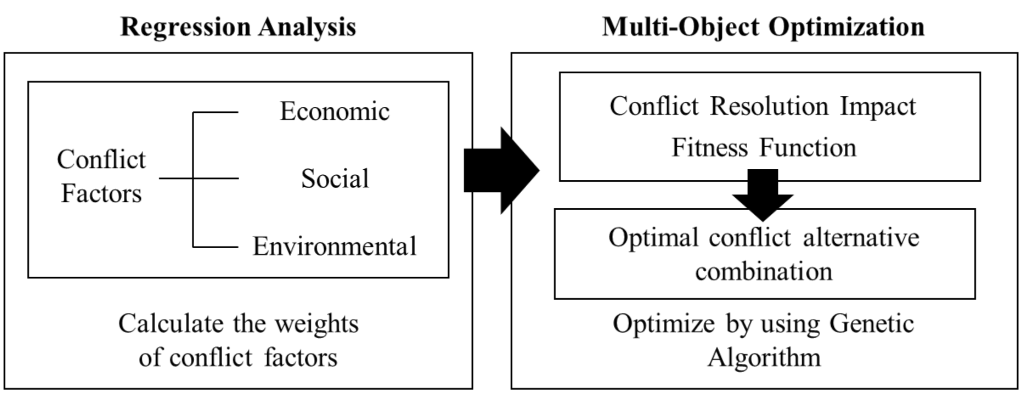

Figure 1. Research framework to find optimal conflict alternative combination.

3 MULTI-OBJECTIVE OPTIMIZATION

3.1 Survey

For developing model, there are some assumptions to make elaborately model. The affection to performance and sustainability is assumed. There may so many factors that related to performance and sustainability. For example, cost, schedule, quality affect to performance and environmental issues, conflict, local development plan affects to sustainability. In this research, it is assumed that only economic, social, and environmental impact affect to performance and sustainability. Economic impact is matched to performance and social impact, environmental impact is matched to sustainability. Based on this assumption, 17 conflict factors and 14 conflict alternatives are deducted and were surveyed to 13 experts. The level of conflict factors on economic, social, and environmental conflict and the extent to which conflict alternatives resolve conflicts were evaluated by 7-Likert scale.

3.2 Weights from Regression Analysis

The level of conflict through the questionnaire were analyzed by regression analysis. The extent to which conflict factors affect economic, social, and environmental conflict level was determined and the results are shown in the Table 1. R square of economic, social, and environmental factors are 0.830, 0.934, and 0.975. These values are sufficient to explain each level of conflict and the coefficient is used as the weight of the conflict factor.

Table 1. Coefficient of conflict factors from regression analysis.

No	Conflict Factor	Economic	Social	Environmental
CF1	Irrational compensation level	0.208	0.221	0.355
CF2	Lack of supporting livelihood	0.358	0.300	0.059
CF3	Inhibition of regional development	0.584	0.711	0.825
CF4	Violation of private property	0.781	0.079	0.049
CF5	Damage to local image	0.266	0.444	0.072
CF6	Irrational compensation procedure	0.141	0.690	0.408
CF7	Opaque business promotion	0.119	0.291	0.137
CF8	Inadequate community participation	0.237	0.161	0.396
CF9	Unilateral location and route selection	0.170	0.065	0.177
CF10	Lack of conflict resolution effort	0.223	0.292	0.096
CF11	Lack of needs of business	0.296	0.057	0.330
CF12	Environmental damage	0.778	0.282	0.164
CF13	Accident likelihood	0.083	0.472	0.142
CF14	Validity of technical alternatives	0.293	0.327	0.153
CF15	Urgency of business	0.384	0.411	0.289
CF16	Disagreement on risk of facility	0.273	0.189	0.302
CF17	Disagreement on existence of cultural properties	0.082	0.132	0.211

3.3 Genetic Algorithm

As a result of the regression analysis in the previous step, the weight of economic, social, and environmental impact was determined. Then conflict resolution impact is calculated by multiplying the impact by the degree of resolution of alternatives as shown as Eq. (1). Because this study is aimed at optimizing conflict both performance and sustainability, conflict resolution impact was used as an objective function to find the optimal combination of conflict alternatives using genetic algorithm.

$$\text{Conflict Resolution Impact} = \sum_{j=1}^{n}\sum_{i=1}^{m} X_i A_j \,\mathrm{t} \tag{1}$$

X_i is weight of the conflict factors, and A_j is degree of resolution of alternatives, t is level of application of alternative. i is the number of conflict factors, j is the number of alternatives. In this study, the number of conflict factors is 17 and the number of alternatives are 14.

The fitness function and constraint are as follows using three impacts. To maximize the economic impact, social impact, and environmental impact, the sum of three functions is optimized as a fitness function. Therefore, the goal of optimization is to maximize the fitness function, as represented by Eq. (2). The t value is deducted as optimal conflict resolution combination from genetic algorithm and it exist in 1 < t < 7 due to 7-Likerts scale.

$$\text{Max F(x)} = w_{eco} \times I_{eco} + w_{soc} \times I_{soc} + w_{env} \times I_{env} \tag{2}$$

w_{eco} is weight of economic conflict, I_{eco} is economic conflict resolution impact, w_{soc} is weight of social conflict, I_{soc} is social conflict resolution impact, $w_{env}$is weight of environmental conflict, I_{env} is environmental conflict resolution impact. In this study, each weight of conflict $(w_{eco}, w_{soc}, w_{env})$ is 0.33.

3.3 Results

Using Matlab 2013, the optimal population t values were obtained using the genetic algorithm. In the 315 iteration, the optimal solution was deducted. The results provide application level for conflict alternatives. As the value of conflict alternative is close to 7, it is effective to resolve the conflict. The results show that CA2, CA1, and CA4 are the most effective for conflict resolution and CA15, CA12, and CA14 are the least effective. According to the results of this study, if conflict alternatives are applied in the order of high value, it is possible to resolve conflicts in the project most effectively (Table 2). In this study, the proportion of economic social and environmental impact was evaluated at the same level. However, if the weight of each project is different depending on the project situation, the result will be different.

Table 2. Application level for conflict alternatives.

No	Conflict Alternatives	Application Level
CA1	Increase of compensation level	6.782
CA2	Increase of compensation coverage	6.828
CA3	Provision of residents' convenience facilities	4.243
CA4	Reselection route	6.256
CA5	Underground route	4.509
CA6	Change of transmission system	3.685
CA7	Holding a public hearing	2.305
CA8	Arbitration through third party	5.468
CA9	Business information disclosure	2.316
CA10	Reimplementation of feasibility studies	5.079
CA11	Reimplementation of environmental impact assessment	1.890
CA12	Application of environmental-friendly materials	1.835
CA13	Provision of environmental countermeasure	2.177
CA14	Additional installation of safety facilities	1.181

With the optimal conflict alternative combination, fitness value is -38.9821, and the mean fitness value is -38.9819 as shown Figure 2. This means that if the optimal alternative is applied, the level of conflict can be reduced by 38.9819.

4 CONCLUSION

This study finds an optimal solution to mitigate conflict through genetic algorithm in terms of economic impact, social impact, and environmental impact. Economic impact is considered as performance and social, environmental impacts are considered as sustainability. The results of this study can be used to determine optimal alternative combinations to mitigate conflicts in construction projects. However, there are some limitations. First, it is difficult to generalize because target project is one. If further data collection is performed, general optimization will be possible. Second, because the application level is a decimal number it is difficult to determine what level to apply. If the optimal combination for the application level is derived as an integer value, it can be determined more clearly. Nevertheless, this study is significant in that it has found an optimal alternative considering both performance and sustainability aspects in order to select a combination of alternatives for conflict resolution.

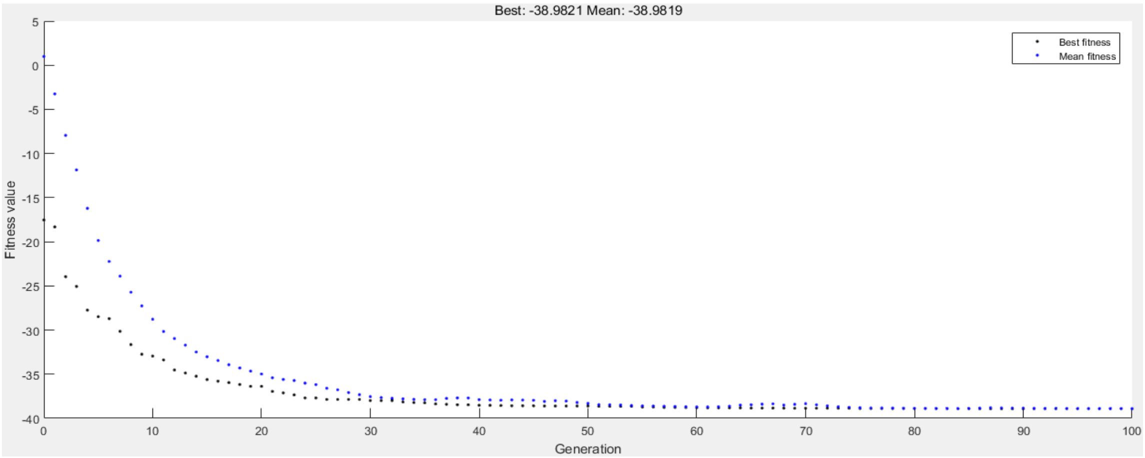

Figure 2. Research framework to find optimal conflict alternative combination.

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