Risk Index Model for Minimizing Environmental Disputes in Construction

Creed S. J. Eom, Ph.D.1; and Joon H. Paek, Ph.D.2

Abstract: Although the number of environment-related disputes is increasing, no risk management approach exists to minimize such disputes at construction sites. The purpose of this study was to develop an environmental risk index model for general contractors to minimize third-party environmental disputes at construction sites. The analytic hierarchy process is used to weigh and calculate an environmental risk index. A case study demonstrated how to apply this model for risk evaluation, on-site monitoring, and environmental management, whereas a comparative analysis revealed that the model decreased the number of disputes to some degree at sites where it was used. This model makes it possible to minimize environmental disputes in the field effectively.

DOI: 10.1061/(ASCE)0733-9364(2009)135:1(34)

CE Database subject headings: Environmental issues; Dispute resolution; Risk management; Site evaluation; Construction management.

Introduction

A common goal in our increasingly complex and interconnected world is to make and preserve a sustainable system for improving the quality of life based on the coexistence of humans and nature. The diversification of public values and an increasing recognition of the merits of environmental preservation have sometimes resulted in public resistance having a negative influence on the successful completion of construction projects. Cheung et al. (2004) noted that “Construction site activities have contributed significantly to the environmental problems, and there is an urgent need to deal with the issue seriously.” Therefore, a systematic and special approach is necessary for minimizing many kinds of environmental problems in construction.

Environment-related disputes are increasing dramatically at construction sites. For example, the National Environmental Disputes Resolution Commission (NEDRC) in Korea settled 1,578 of the 1,908 cases of environmental pollution disputes it received during the period 1991–2006 (MOE 2007). The majority of these cases (1,366 cases, 86.6%) were related to noise and vibration, and the remainder involved air pollution (124 cases, 7.9%), water pollution (55 cases, 3.5%), sea pollution (9 cases, 0.6%), and others (21 cases, 1.3%). Environmental dispute mediation status report (NEDRC 2006) also noted that “The current status of environmental dispute arbitration shows that cases related to noise and vibration occur more often than other kinds of cases, and are still increasing.” A study of the cases in 2006 revealed that most environmental disputes are related to home damage and emotional problems resulting from noise and vibration in infrastructure development, such as the construction of new apartment buildings or roads (MOE 2007). The resulting environmental petitions pose numerous risks to the construction process that include project delays, cost overruns, design changes, and schedule expansion. Efforts to reduce on-site disputes would increase the possibility of meeting the project goals successfully.

The purpose of this study was to develop an environmental risk index model (ERIM) to enable general contractors to minimize third-party environmental disputes at construction sites using information obtained from an on-site environmental risk evaluation process. The ERIM is based on the analytic hierarchy process (AHP) method and a single linear model to weigh and calculate the environmental risk index (ERI). The application of ERI and managerial index to the project monitoring process would improve the probability of successful projects, and would also help counter weaknesses in environmental management efforts aimed at minimizing on-site environmental disputes.

A case study is used to show how this model is applied to risk factor selection, evaluation, on-site monitoring, and feedback. The study also reveals the impact of the model on major project success factors (e.g., cost, schedule, and quality) and decrease in the number of disputes on project sites where the model is used.

Literature Review

Many studies on environmental problems have been conducted in the construction industry over the past 30 years (Cheung et al. 2004; Chen et al. 2005). Prior research on this topic can be categorized as environmental management (EM), environmental impact assessment (EIA), environmental performance evaluation (EPE), environmental dispute resolution, or other. EM in a construction context was first used in the U.S. National Environmental Policy Act of 1969 (Warren 1973), and the concept of EM in construction grew with the introduction of environmental inspectors in the late 1970s. Moreover, as Chen et al. (2005) said, enthusiasm for establishing an EM system in general contractors grew quickly following the introduction of two impor-
tant EM standards, BS 7750 (enacted in 1992) and the ISO 14000 series of standards (enacted in 1996). In 1999, the ISO 14031 EPE, part of the ISO 14000 series, was introduced for assessing environmental performance related to ongoing management and operational systems. However, it is not easy for a company to establish an EPE system (Tam et al. 2002), but these EM standards are considered as guidelines to help the construction industry change from passive one-sided construction management techniques for pollution reduction to active and all-encompassing environmental management construction practices (Chen et al. 2005).

The framework for the EIA or environmental impact statement (EIS) of the U.S. Environmental Protection Agency (1984) was originated in the National Environmental Policy Act, enacted in the United States in 1969. This was adopted as another guideline for designers and contractors in assessing a project’s impact on the environment. However, as the EIA process presents guidelines for project pollution reduction planning only in the project planning stage, it cannot provide overall environmental assessment tools to contractors in the preconstruction and construction stages.

Even as these standards and legislation were being introduced, environmental challenges and conflicts concerning environmental decisions grew rapidly (Lach 1996). Various methods have been suggested for resolving environmental disputes, including public participation and alternative dispute resolution (ADR). ADR includes a range of techniques for settling disputes without resorting to litigation, or for reaching a settlement more efficiently within existing litigation proceedings. The U.S. Environmental Protection Agency (USEPA) is committed to dealing proactively with problems and concerns in the EIA and project execution stages that may lead to conflict, and to resolving disputes as early as possible and in constructive ways (USEPA 2000).

Current research approaches have addressed specific environmental issues in isolation. These include environmental good practices on construction sites (Coventry and Woolveridge 1999), environmental monitoring and inspection (Dodds and Sternberger 1992), the role of field auditing in environmental quality assurance (Claycomb 2000), performance assessment for environmental pollution protection (Cheung et al. 2004), environmentally conscious construction planning (Chen et al. 2005), and public participation in resolving environmental disputes (Allen 1998). However, to our knowledge, there have been very few studies on examination of activities related to minimizing the possibility of conflict on construction sites from the perspective of general contractors. In this paper, we introduce a comprehensive tool for construction contractors, concentrating on the development of an on-site evaluation and monitoring system in the preconstruction and construction stages aimed at minimizing environmental disputes.

### Risk Management Approach

The research suggests that an environmental risk index model for classifying environmental risk factors and developing management solutions for risk minimization could be useful. Environmental disputes can be considered as a type of risk in the construction process, and the possibility of disputes can be expressed with an ERI measured for construction sites in the preconstruction and construction stages.

A multicriteria decision-making process is required because more than one evaluation class is used in the hierarchical structure that affects environmental risk. To set up a simple and widely applicable model, we examined the risk management process including the establishment of risk management objectives, classification of hierarchical risk criteria, weighting of environmental risk factors, and calculation of an overall score using the AHP and the simple additive linear model.

The AHP is a powerful and flexible decision-making process for setting weights and making the best decision when both qualitative and quantitative aspects of a decision must be considered (Chen et al. 2005). This is recommended by construction researchers as a useful multicriteria assessment tool because of its strong mathematical foundation and its flexibility in the choice of ranges at the subcriteria level (Khasnabis et al. 2002). Despite several flaws, it is considered both technically valid and practically useful, and can be easily applied for environmental risk management by a site manager with simple tools such as an online application or a spreadsheet.

In this research, AHP method is used because the ERIM process must consider flexibility in scope-setting criteria and multiattribute decision making to obtain relative weights that reflect a preference for environmental risk factors that have qualitative criteria. A simple additive linear model for single-criterion vector calculation was selected for computing the overall performance, producing using multicriteria values from the sum of weighted individual values.

The weights of risk factors derived from the AHP method were applied to select key factors to reduce the risk of each project. Weak factors with poor performance in the project formed the basis for the benchmarking process to compare the performance of different projects with regard to each factor.

### Environmental Risk Index Model

The ERIM methodology uses framework for environmental management based on a risk index. The ERIM framework is divided into three logical parts: the environmental management strategy system, the on-site project evaluation system, and the environmental monitoring system.

The roles of the environmental management strategy system are to identify the environmental risk management objectives, develop a hierarchical environmental risk structure, and identify the factors influencing environmental risk. The roles of the on-site project evaluation system are to calculate the weight of each factor and to compute on-site evaluation scores using the AHP method to check project management efforts for each influential factor. The roles of the environmental monitoring system are to identify managerial factors based on information obtained from the project evaluation process, monitor the contractor’s risk management performance continuously based on the managerial factors, and feed back the monitoring results. The following sections explain the ERIM shown in Fig. 1.

### Environmental Risk Index Model Objective

The objective of the ERIM is to complete a construction project successfully by minimizing environmental disputes. In a construction project, the ultimate objective of the risk management system is successful completion of the whole project, whereas specific objectives of the project are established in terms of cost, time, and quality (Paulson and Barrie 1992). Environmental disputes result in cost overruns due to claim resolution and schedule delays, and poor quality due to inconsistent processes or stakeholder demoralization. It makes no sense to pursue only one iso-
lated objective as equal importance must be given to each of them, and none can be sacrificed (Chua et al. 1999). Therefore, the objective of environmental risk management in this paper is the successful project completion that satisfies a balance among cost, time, and quality by minimizing possible environmental conflicts at the construction site.

**Identification of the Environmental Risk Management Hierarchical Structure**

A hierarchical risk management approach was used to create the multicriteria environmental decision-making process. In such a hierarchical structure, the top class (Class 0) is the overall objective of risk management for minimizing environmental disputes at construction sites. The next class (Class 1) would be the type of construction including houses and buildings (e.g., rehabilitation, new construction, and nonresidential buildings) and infrastructure (e.g., factories, harbors, dams, water supply and drainage facilities, railways, subways, highways, and bridges). The risk types (Class 2) include noise, vibration, dust, water pollution, building demolition, earth subsidence, odor, and the infringement of sunlight rights. In Class 3, the project’s life cycle is divided into five phases to facilitate practical evaluation during the life-cycle process: predesign, design, preconstruction, construction, and post-construction phases. Risk factors (Class 4) are analyzed from the viewpoint of the contractors, and include environmental risk factors in the preconstruction and construction phases. The suggested hierarchical structure and class sets were based on the results of previous research (Shioda 1994; CERIK 1996; USEPA 2003), but a different set could be possible depending on the specific project conditions or the contractor’s strategy.

**Identification of Environmental Risk Factors**

The environmental risk factors are organized to reflect specific site conditions according to the construction life cycle. These should include the major factors for reducing environmental disputes at construction sites. Although reasons for environmental disputes may include noise, dust, and other environmental factors, political, social, and cultural influences related to the interests of neighboring communities may be involved (CERIK 1996).

**Calculation of Factor Weights**

Relative ratings for factor weights are developed through AHP for sizing the hierarchical structure. Unlike interval scales used in utility theory, the factor weights derived from the priority of each AHP factor are ratio scales that reflect not only the ranking of alternatives, but also the degree of importance. The weights are determined by applying pairwise comparison among the factors by quantifying Saaty’s 1–9 scales, normalizing the geometric mean of each row in a pairwise comparison matrix, and finally by checking the condition of the consistency ratio (CR) (Saaty 1980; Saaty and Vargas 1991).

**Identification of Key Factors**

The Pareto (80–20) rule is used to define the key factors. Generally, the top 20% include critical factors that account for approximately 80% of the total management effort. Because AHP was developed to set priorities involving subjective judgment on the strategic importance of factors related to the performance of each factor, the higher the weight of each factor is, the more effective the overall environmental risk management will be. Therefore, factors that account for the top 20% of the weights in the Pareto curve are assumed to be the key factors. The percentage of the cutoff rate can be changed according to the contractor’s policy.

**Computation of Evaluation Score and Environmental Risk Index**

The evaluation score (ES) and the ERI are calculated from the on-site performance evaluation. The ES is a questionnaire rated on a scale of 1–10. A high score means that the environmental management activity is performed better. The rating level of each factor can be determined based on the site engineer’s judgment. ERI is the normalized score of each risk factor particular to the site environmental risk conditions, and is created by multiplying the weight of each factor by the evaluation score of each factor. A high score means that the condition of the project is less environmentally risky. The total ERI score for the overall performance is calculated with a simple additive linear model as follows:

\[
\text{Total ERI} = \sum_{i=1}^{n} \text{ERI}_i = \sum_{i=1}^{n} w_i \times \text{ES}_i
\]

where \( i = \) number of risk factors, the environmental risk index for risk factor \( i \) (ERI\(_i\)) is computed by multiplying the normalized...
Improvement of environmental management.

The effective environmental management performance will be determined by the contractor’s attention to managerial factors. There are managerial factors defined as follows: the higher the value of MR is, the more effective the environmental management performance will be. The MR is the normalized weight of managerial factors defined as follows:

\[
MR_i = \frac{\text{weight of managerial factor } i}{\sum_j \text{weight of managerial factor } j} \times 100(\%)
\]

where \( j \) = number of managerial factors. The weights of the managerial factors are determined using the factor weights described earlier: the higher the value of MR is, the more effective the factor to improve the management performance will be. Therefore, the contractor should pay more attention to managerial factors that produce a higher value of MR for the effective improvement of environmental management.

Identification of Weak Factors

Even if one site has a higher ERI than another site, it may also have weak factors, the performance of which are poorer than the average performance of other sites. Such factors are the weak factors of that specific site.

Identification of Managerial Factors

Managerial factors are those key factors and weak factors necessary to enhance the performance of the environmental management activities. Reinforcing the key factors will improve the performance of critical portions of the project, and strengthening the weak factors will minimize the risk. This will result in the entire construction process maintaining its competitive edge over other projects. Because contractors have limited resources, they must select an effective management strategy for improving the performance of each project. The managerial rate (MR) is used to evaluate the importance of specific managerial factor compared to other managerial factors. The MR is the normalized weight of managerial factors defined as follows:

\[
MR_i = \frac{\text{weight of managerial factor } i}{\sum_j \text{weight of managerial factor } j} \times 100(\%)
\]

Monitoring and Feedback of Managerial Factors

An ideal project site would be one with the highest ERI scores for each factor. At a specific point in the preconstruction or construction processes, the contractor would evaluate the project environmental management performance to see whether the project site has achieved the ideal project level for all managerial factors. The contractor would develop the long-term management plan further if the desired level has been achieved.

Further, importance-performance analysis (IPA) would be used to manage environmental risk factors more specifically. IPA is a two-axis analysis model that is widely useful in management, and was originally developed as a marketing resource (Martilla and James 1997). One-dimensional performance indicators (evaluation scores) may be combined with another factor such as importance (weights) to yield additional insight into existing processes and clarify strategies for feedback.

Case Study

An environmental risk index can be developed and the management conditions can be evaluated comprehensively and in detail by applying the ERIM in practice. The scope of the case study was restricted to the environmental risk index evaluation of noise and vibration at new apartment building project sites during the preconstruction and construction stages to facilitate the application of the model. The risk factors for the case study were extracted from an analysis of five previous research results and in-depth discussion with three environmental construction specialists. These environmental risk factors were organized into four risk factors for the preconstruction phase (RF31–RF34) and six risk factors for the construction phase (RF41–RF46) as shown in Table 1. These risk factors were weighed using a pairwise comparison questionnaire, and the actual performance of each factor on the construction site was evaluated using a structured simple rating questionnaire.

Twenty new apartment building projects under construction in South Korea were selected from a group of 24 projects in the process of being done by a general contractor using purposeful
quota sampling for the case study. In addition, 100 structured questionnaires were distributed to site engineers with more than 5 years of field engineering experience in environmental management during the period from June 21 to July 10, 2000. In total, 82 questionnaires covering 18 sites were returned. In the survey, 78 of 82 respondents (95.1%) replied that they considered the risk factors to be appropriate, and 84% replied that the factors were very appropriate. Again, selected factors were designated as environmental risk factors.

A spreadsheet program for AHP was developed using Microsoft Excel (Microsoft Corporation) to define the relative priority of factors. An analysis of pairwise comparison data using AHP methods for Class 3 revealed that the preconstruction phase had a somewhat higher priority [0.548] than the construction phase [0.452]. This means that the contractors understood the importance of preconstruction activities, such as the review of designs and specifications, and environmental planning management. Therefore, it is more desirable to do everything possible to minimize environmental problems in the preconstruction phase. The weighted results of individual risk factors in the preconstruction and construction phases for Class 4 are shown in Table 2. The weight of each factor by the site's evaluation score for each factor can be performed well. RF34 (proper combination of construction equipment) and RF45 (avoidance of the use of old equipment) in the construction phase did not have much influence on environmental risk minimization. Improving the performance of the key factors is more effective in enhancing the overall performance of management efforts than that of other factors. RF34 and RF46 both involve the local residents and have been rated quite high due to the importance of ensuring the residents' participation and friendly relationship with the contractors in the decision-making process to minimize the occurrence of environmental disputes.

Next, the ES and ERI were calculated from the question on how successful the environmental management activities were for minimizing the risk. As Table 2 shows, the ES is the evaluation score of each risk factor using a ten-point Likert scale and the average evaluation score is the average value of total scores from the 82 respondents at the 18 sites. The scores for Sites A, B, and C were specifically selected from among the 18 sites for comparative analysis because they had questionnaires completed by more than three engineers. The ERI was determined by multiplying the weight of each factor by the site's evaluation score for each factor. The total ERI is the sum of the ERI of each factor. Thus, the performance at Site C [6.444] was better than the average performance of the 18 sites [5.601], and better than Site A [4.829] or Site B [6.059].

Fig. 2 shows the evaluation scores of the individual risk factors for Sites A, B, and C in general, the environmental management activities at Site C were effective in reducing the environmental risk. The participation of the local residents was not particularly well handled in the preconstruction phase (RF34), but Site C corrected this during the construction phase as shown in the result for RF46.

Fig. 3 shows the ERI distribution. The ERI score for Sites C and B are higher than that of Site A. The indexes for RF33 (development of an appropriate construction and environmental management plan) and RF42 (setup up of antipollution equipment at the construction site) were judged to be important and appeared to be performed well. RF34 (local residents' opinions and participation with the decision-making process) and RF46 (continuous involvement of the residents during all activities at the site), however, were not executed at a level that was appropriate for their importance.

Although Site C was found to be the best-performing site among all the others, the rating scores of two factors (RF31 and

Table 2. Evaluation Score and Environmental Risk Index

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Weight (w)</th>
<th>Evaluation score (ES)</th>
<th>Environmental risk index (ERI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF31</td>
<td>0.100</td>
<td>6.382</td>
<td>5.872 6.489 4.989 0.638</td>
</tr>
<tr>
<td>RF32</td>
<td>0.092</td>
<td>4.121</td>
<td>3.212 4.795 5.121 0.379</td>
</tr>
<tr>
<td>RF33</td>
<td>0.198</td>
<td>5.782</td>
<td>5.515 5.926 7.012 1.146</td>
</tr>
<tr>
<td>RF34</td>
<td>0.158</td>
<td>2.081</td>
<td>2.382 4.511 2.021 0.329</td>
</tr>
<tr>
<td>RF41</td>
<td>0.085</td>
<td>7.549</td>
<td>7.723 6.757 7.691 0.640</td>
</tr>
<tr>
<td>RF42</td>
<td>0.120</td>
<td>8.884</td>
<td>7.344 9.121 9.232 1.063</td>
</tr>
<tr>
<td>RF43</td>
<td>0.098</td>
<td>7.752</td>
<td>6.523 8.195 8.581 0.762</td>
</tr>
<tr>
<td>RF44</td>
<td>0.034</td>
<td>5.326</td>
<td>5.821 7.132 7.544 0.179</td>
</tr>
<tr>
<td>RR45</td>
<td>0.014</td>
<td>7.627</td>
<td>6.983 8.356 7.499 0.104</td>
</tr>
<tr>
<td>RF46</td>
<td>0.102</td>
<td>3.543</td>
<td>1.782 2.547 7.937 0.362</td>
</tr>
<tr>
<td>Total ERI</td>
<td></td>
<td></td>
<td>5.601 4.829 6.059 6.444</td>
</tr>
</tbody>
</table>
RF34) in Fig. 3 fall short of the others. Factors with inferior ratings are identified as weak factors, and they are also benchmarks for the performance evaluation of other project sites. These factors must be managed to obtain an ERI as high as the other sites.

The managerial factors of Site C include both key factors, and weak factors, such as RF31, RF33, and RF34. The overall environmental risk management performance of Site C can be improved by managing these factors effectively. The MRs of the managerial factors are RF33, 43.4%; RF34, 34.6%; and RF31, 21.9%. These rates represent the relative importance of the managerial factors in improving the management performance at the project site. These results help the contractor at Site C strengthen the project’s weak areas based on the predetermined managerial factors and MRs. Then the contractor continuously compares Site C’s overall scores and the scores of the managerial factors during the construction process. When the contractor at Site C does not achieve the ideal level of ERI for the managerial factors, that is the maximum score in RF31 and RF34 compared to the scores of the other projects. The contractor must increase management efforts in the current and in future projects.

Although managerial factors identified in this research serve as important guidelines, other factors are also considered important, so an IPA was conducted to gain further insight. Fig. 4 shows the IPA of Site C conducted with the application of relative weight (importance) and evaluation score (performance). The four quadrants shown in Fig. 4 are categorized by individual importance and performance average. RF34 (local residents’ opinions and participation in the decision-making process) and RF31 (review of environmental regulations, design drawings, and specifications) fall into the “concentrate here” category and are very important; as the performance results are below average, these require more concentrated management. RF33 (development of an appropriate construction and environmental management plan), RF42 (setup of antipollution equipment at the construction site), and RF46 (continuous involvement of the residents during all activities at the site) fall into the “Keep up the good work” category and exhibit high weights and performance. These are areas that require continued maintenance of good performance. These results provide a broader perspective on where to drive changes rather than simply relying on performance indicators alone.

**Impact of the Model**

A comparative study of performance results was conducted in February 2007 for two groups of domestic projects undertaken by South Korean general contractors to examine the impact of environmental conflicts on project success factors (e.g., cost, schedule, and quality) and to see the effect of the environment-related complaints after applying this model.

Table 3 includes 20 new apartment building projects completed during the period January 2001 to December 2005. The general sites were the ones controlled and managed using conventional practice, and the pilot sites were ones in which ERIM was used in the contractor’s environmental management program since March 2002. The survey was conducted among the engineers who participated in the construction management process for cost management (project cost and cost deviation ratio), time management (schedule and schedule deviation ratio), quality management (number of defects and rebuilds per apartment unit), and environmental disputes (the number of environmental complaints per apartment unit).

A correlation analysis was conducted for the cost deviation, schedule deviation, and the number of defects or rebuilds compared to the number of environmental disputes. The analysis showed that although the number of defects and rebuilds had a below-average correlation with the number of disputes (0.310), there was an above-average correlation of the cost deviation ratio (0.512) and the schedule deviation ratio (0.480) with the number of disputes. Therefore, if project conditions other than those used in this model are similar, then it can be said that environmental complaints decreased as the construction costs and schedule delays decreased and that this model has a positive effect on the success of the project.

In the comparison of the frequencies of environmental disputes between the pilot sites and the general sites, the Student’s t-test shows that the differences in data sets listed in Table 3 are significant in that the t-value of 0.042 is less than the significant probability of 0.050 when the confidence interval is 95%. Therefore, the differences in the complaint frequencies between the pilot group and the general group are significant, and when this model is applied, the frequency of environmental disputes decreases to some degree.
Summary and Conclusions

Previous research on environmental management from the contractor’s perspective has largely concentrated on environmental planning and antipollution measures. The purpose of this study was to develop a risk index model to minimize environmental disputes at project sites. It is possible to suggest a risk management approach to resolve civil appeals that result from environmental pollution at construction sites. This paper has described the development of a practical environmental risk index model framework for environmental management based on a risk index, which consists of three parts: environmental management strategy system, on-site project evaluation system, and environmental monitoring system. The methodology identifies management criteria using information derived from project evaluation processes and makes use of them in the environmental risk management process.

The ten suggested risk factors are composed of the necessary elements in environmental management activities for minimizing environmental problems. The computed weighted results show that RF33 (development of an appropriate construction and environmental management plan) and RF34 (local residents’ opinions and participation in the decision-making process) are the most important risk factors.

The case study showed how to apply this model to on-site activity evaluation and how to develop a risk index for practical management use. A field survey questionnaire was conducted to investigate the effect of noise and vibration problems at new apartment construction sites. In the case of Site C, the managerial factors were RF31 (review of environmental regulations, design drawings, and specifications), RF33, and RF34. Therefore, the contractor at Site C should increase management efforts in those areas. The results of the IPA place RF34 and RF31 in the concentrate here category. In contrast, RF33, RF42 (setup of antipollution equipment at the construction site), and RF46 (continuous involvement of the residents during all activities at the site) fall into the “keep up the good work” category.

A comparative analysis on the performance of ten pilot sites where the model was applied during the project life cycle, and ten general sites where the model was not used, showed that environmental conflicts at sites caused a deviation of cost and schedule, and when this model was applied, the frequencies of complaints decreased to some degree.

Recommendations

Although the case study was limited to construction projects conducted in South Korea, the suggested model would be applicable to construction projects worldwide with appropriate modification of the risk factors and data weights. Environmental disputes result from complex and interrelated factors with political, economic, and legal elements. It is necessary to develop a modified model with the possible addition of a different hierarchical structure and other risk factors to analyze more practical situations. From the contractor’s point of view, it is desirable to understand the possibility of environmental risk, concentrate on identifying elements for minimizing environmental problems, and develop a risk management system for minimizing environmental matters. In addition, the early involvement of local residents in the construction process is crucial.
life cycle—as early as the planning and design phases—is essential for the reduction of complaints. The contractor must have an open attitude to continuous resident participation in the project life cycle so that residents understand what is happening. This creation of a partner relationship is as important as traditional antipollution efforts.

Many environmental disputes are caused by an inadequate review of design drawings and specifications in the planning and design phases. As this study is appropriate for management activities of contractors in the preconstruction or construction phases, it cannot solve possible problems in the design phase. Therefore, value engineering and design reviews in the preconstruction phase will be the solutions in reducing the risk using ERIM framework along with environmental management activities based on EIS and EM standards.

Construction and Economy Research Institute of Korea

References

Sincere thanks to the anonymous reviewers and others for their help.

Acknowledgments

The writers thank the companies and engineers who participated in the survey for their frank responses. They also express their sincere thanks to the anonymous reviewers and others for their helpful comments and constructive criticism.

References


